NUCLEAR SCIENCE ABSTRACTS

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BIOLOGY AND MEDICINE

1623 Hemin Synthesis in spleen homogenates. Kurt I. Altman and Kurt Salomon. AECU-422 (UR-78), June 3, 1949. 6p.

Tests with biochemical methods of the possibility of hemin synthesis from labeled (C^{14}) glycine in spleen homogenates in the manner previously applied to bone marrow homogenates (Altman, et al, *J. Biol. Chem 177*, 489 (1949)) are reported. Rabbit spleens were chosen as the source of the homogenates, spleen from several rabbits having been pooled for each experiment. Preparation of the spleen homogenate is described. The determination of C^{14} activity was carried out with an ionization chamber apparatus previously described by Altman, et al *(J. Biol. Chem. 176*, 319 (1948)). The results obtained are tabulated. One experiment (3 hours incubation) was carried out in a large Warburg vessel permitting the collection of evolved C dioxide in 5 N NaOH with subsequent isolation as Ba carbonate. The C^{14} activity of the Ba carbonate thus obtained was quite low (4.8×10^2 disintegrations/min mole), indicating that only very small amounts of the methylene C atom of glycine were converted to C dioxide in spleen homogenates. The results reported indicate that hemin synthesis can be carried out by rabbit spleen homogenates utilizing the methylene C atom of glycine as a precursor.

1624 The path of carbon in photosynthesis. VI. M. Calvin. AECU-433(UCRL-387), June 30, 1949. 67p.

This paper is a compilation of the essential results obtained by the author and his colleagues in the determination of the path of carbon in photosynthesis. A brief historical background is given. There are discussions of the dark fixation of photosynthesis and of methods of separation and identification including paper chromatography and radioautography. The definition of the path of carbon in photosynthesis by the distribution of radioactivity within the compounds is described.

1625 The rate of elimination of C^{14} administered as $BaC^{14}O_3$. J. Govaerts. AECU-434 (UCRL-388), July 15, 1949. 11p.

The fate of C^{14} fixed by the lungs as barium carbonate has been studied in mice to evaluate the hazards which the use of the radiocarbon isotope C^{14} might present to laboratory workers. The results obtained indicate that C^{14} introduced into the lungs as a fine suspension either by intravenous injection or by insufflation in the form of barium carbonate is very rapidly excreted as carbon dioxide. The overall retention of C^{14} is less than 15% 12 hr after administration. Additional studies were made using intravenous injection of sodium carbonate containing C^{14}; results were similar to those obtained with barium carbonate. It appears from these data and from those obtained by other workers that the dangers that might be encountered by those who work with C^{14} are not as great as expected.

1626 Thermal decarbonylation of pyruvic acid and ethyl pyruvate. II. Pyruvate metabolism in green algae. Richard Millington Lemmon. AECU-452(UCRL-315), Aug. 1, 1949. 52p.

Pyruvic acid and ethyl pyruvate were synthesized with the α-carbon atom labeled with C^{14}. It was found that the carbon oxides which are evolved when these compounds are heated at moderate temperatures contained no radioactivity. Therefore, it was conclusively established that the oxides of carbon come from the carboxyl, and not the carbonyl group. Pyruvic acid labeled in the methyl position with C^{14} was administered to green algae. One experiment was carried out while the plant was subjected to strong illumination for 5 min, the other experiment was conducted in the dark for the same period of time. It was found that the ability of the plant to form labeled compounds from the radioactive pyruvic acid was much greater in the light than in the dark. In both cases most of the radioactivity appeared as a single compound in the liquid fraction obtained from the algae. Very little labeled sugar was formed in the light and none appeared in the dark. It was established that radioactive alanine and aspartic acid were formed under both conditions. 24 references.

1627 Experiments with deuterium as an indicator. Wilhelm Franke and Joseph Mönch. *Biochemische Z. 319*, 174-83(1949) Jan. 5 (in German).

Experiments illustrating a simple example of biological H transfer, the bacterial hydrogenation of fumaric acid, as determined by the addition of deuterium are presented. The method, technique, and the results are described. The results indicate that when fumaric acid is hydrogenated by deuterium gas in the presence of B. coli, an essentially deuterium-free succinic acid is obtained, while the deuterium content in the gas phase at the same time through exchange is reduced only about one third. Since the deuterium which is bound to the C atom in the fumaric and succinic

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exchange is not capable of a direct exchange with the solvent water, and the reaction lies wholly on the side of the succinic acid, it is concluded that the results of the reaction cannot be the same as those described for the dehydrogenation of succinic acid with methylene blue.

1628 Metabolism of cardiac muscle: utilization of C^{14} labelled pyruvate and acetate in diabetic rat heart and diaphragm. O.H.Pearson, C.K. Hsieh, C.H.Dutoit, and A.B.Hastings. *Am. J. Physiol. 158*, 261-8(1949) Aug. 1 (See also NSA-3-1504).

The metabolism of pyruvate and acetate in cardiac and diaphragm muscle of normal and diabetic rats was studied in vitro through the use of C^{14}. Oxygen consumption, pyruvate utilization, lactate production and the $C^{14}O_2$ production from $CH_3C^{14}OCOOH$ and $CH_3C^{14}OOH$ were measured. The technique is described in detail. Diminished pyruvate utilization was observed in both cardiac and diaphragm muscle of diabetic animals. The addition of insulin, in vitro, increased the conversion of labelled pyruvate to $C^{14}O_2$ in the diaphragms of the diabetic animals but not in cardiac muscle. A diminished acetate utilization was observed in diabetic diaphragm muscle, but was unchanged from normal in diabetic heart muscle. The addition of insulin, in vitro, had no effect on the conversion of labelled acetate to $C^{14}O_2$. The measurement of the radioactivity of the fat and protein fractions revealed that C^{14} incorporation from $CH_3C^{14}OCOOH$ was five-fold greater in diaphragm muscle than in cardiac muscle.

1629 On the turnover of purines and pyrimidines from polynucleotides in the rat determined with N^{15}. Peter Reichard. *Acta Chem. Scand. 3*, 422-32(1949) (See also NSA 3-611).

A method is described for the preparation of cytosine and thymine from 30-50 mg of desoxyribonucleic acid by the use of hydrolysis with formic acid and partition chromatography on starch. The conversion of cytidine into uridine with the help of 0.4 N acid and aqueous pyridine was also investigated; orotic acid was demonstrated to be a precursor of the pyrimidines and was compared with glycine. Some supplementary experiments were made with the purines from the spleen and kidney of the rat with N^{15}-glycine, with the object of investigating the possibility of using adenine as a precursor for guanine. 13 references.

1630 P^{32} in the nervous system. The phosphate exchange of the nervous system investigated with the help of the isotope method. Fritz Roeder. Göttingen, Muster-Schmidt, 1948. 32p.

This book covers the knowledge to date concerning the basic changes and reactions taking place in the central nervous system. Radioactive phosphorus was used in the investigations explained and described. The pathological and physiological changes in the brain are contrasted with the basic chemical reactions that take place; hormone control and blood regulation of brain functions are also discussed.

1631 Radioactive tracer techniques. G.K. Schweitzer and I.B. Whitney. New York, Van Nostrand, Inc. 1949. 241p.

This work has been designed to serve as a guide to laboratory work with radioactive tracers. The following topics are treated: radioactive hazards, the operation and construction of a radio-laboratory, precautions necessary in a radio-laboratory. Groups of basic tracer and radioactivity experiments in the fields of chemistry, physics, and biology are given. Various useful information is presented in appendices.

1632 The uptake of C^{14} of carboxyl-labeled glycine into the protein of torula utilis. Felix Friedberg and Arthur H. Webb. *J. Bact. 58*, 151-2(1949) Aug.

Cells of Torula utilis were incubated with carboxyl-labeled glycine in an atmosphere of oxygen and under other conditions to determine the rate of uptake of C^{14} and the influence of various factors on its incorporation in cell protein. The method and procedure are described in detail. The incorporation of the C^{14} into the cell protein was inhibited by cyanide and by anerobic conditions and was enhanced by glucose and calcium; drying and grinding of the yeast cells prevented the C^{14} uptake. The average activity of the radioactive protein produced under normal conditions was 0.66 counts/sec/mg of protein when a trace of the C^{14}-labeled glycine with an activity of 1,360 counts/sec was added to 2 ml of the medium. It is indicated that an oxidative mechanism is necessary for C^{14} uptake in microorganisms and that this mechanism is enzymatic.

BIOLOGY AND MEDICINE (continued)

1633 The use of P^{32} labeled glycerophosphate in the study of yolk phospholipids. J.W.T. Spinks, C.C.Lee, and J.B.O'Neil. *Can. J. Research 27B*, 629-37(1949) July (See also NSA 1-876).

Labeled sodium glycerophosphate has been prepared by phosphorylating glycerol with sodium dihydrogen phosphate containing P^{32}. After the labeled sodium glycerophosphate had been fed to a laying hen, radiophosphorus from glycerophosphate appeared in the shells, whites, and yolks of the eggs. The uptake in different eggs followed a pattern similar to that found for inorganic phosphate, the maximum occurring at the fourth or fifth egg. Comparative studies using P^{32} labeled sodium glycerophosphate and trisodium phosphate indicate that the rate of utilization of the phosphorus from glycerophosphate is less than the rate of utilization of the phosphorus from inorganic phosphate. The possibility of an enzymatic hydrolysis of glycerophosphate followed by the incorporation of the resulting phosphoric acid into the phospholipids and the phosphorylation of lower glycerides (partially hydrolyzed fat) by inorganic phosphate as a mechanism for phospholipid formation is discussed. 24 references.

1634 Utilization by plants of phosphorus in farm manure. I. Labeling of phosphorus in sheep manure with P^{32}. Clayton McAuliffe and Michael Peech. *Soil Sci. 68*, 179-84(1949) Aug. (See also NSA 3-1506).

To study the fertilizer value of phosphorus in farm manure, two methods for labeling the inorganic and organic forms of phosphorus in sheep manure with P^{32} were investigated: feeding the sheep radioactive KH_2PO_4 with the forage; and, incubation of the sheep feces with radioactive KH_2PO_4 as well as with radioactive superphosphate for 22 days. The dose of P^{32} was 10 mc. It was found that 84% to 90% of the phosphorus in the organic forms in the sheep feces was labeled when the animal was fed the $KH_2P^{32}O_4$ supplement with the forage. The organic phosphorus labeled varied for the different fractions, ranging from 43% to 94% for samples incubated with $KH_2P^{32}O_4$ and from 22% to 50% for samples incubated with radioactive superphosphate. 11 references.

1635 The influence of infection on the hematological effects and mortality following mid-lethal x-radiation. L.R. Bennett, Paul E. Rekers, Marion Kresge, and Joe W. Howland. AECU-421(UR-76), May 24, 1949. 16p.

Frequent blood cultures were made on 54 dogs receiving mid-lethal whole body x-radiation. A relatively high incidence of positive blood cultures (17%) was found. Infection appeared to be definitely related to mortality in animals surviving the first two weeks of irradiation, and to a lesser extent in animals dying at an earlier time. No direct correlation between the leukocyte level and the bacteremia was found. A possible correlation between the definite anemia of dying animals and infection has been made. The presence of E. coli and gram negative organisms within the circulating blood appears to be definitely related to the subsequent death of these animals.

1636 Studies in the hyaluronidase - hyaluronic acid system. II. The reaction of x-irradiated hyaluronate with hyaluronidase. Robert E. Brooks and Herman Schneiderman. AECU-425(UCLA-36), July 14, 1949. 22p.

It has been reported (AECU-170) that x-irradiation of bovine vitreous humor potassium hyaluronate results in a loss in viscosity due to irradiation, and a continuing loss for about 5 hr after irradiation. In this report, the interaction of the irradiated hyaluronate with hyaluronidase and the effect of x-irradiation on the enzyme are considered. The previously reported loss in viscosity has been confirmed experimentally with bovine vitreous humor and human umbilical cord hyaluronate. The viscosity dilution curve for irradiated and nonirradiated hyaluronate is similar in the range of concentrations used. For a similar initial relative viscosity, the reaction of hyaluronidase with irradiated hyaluronate is much slower than with nonirradiated hyaluronate. Suggestions are made as to the mechanisms of these effects and their relation to radiation damage. Results suggest that any damage resulting from x-irradiation of the hyaluronidase-hyaluronic acid system is due more to the reduction in viscosity of the hyaluronic acid than to the action of x-rays on the enzyme.

1637 Note on an x-ray flat-field filter. Benedict Cassen. AECU-436(UCLA-31), Aug. 8, 1949. 8p.

The design theory is given for a copper x-ray filter that combines the action of removing soft radiation and equalizing the biological dosage over a large flat field. The filter was

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constructed by cutting out 40 circular sheets of .0017-in. copper foil of radii fitting the formula. These sheets were stuck together with Duco cement. Such a filter has been used successfully for almost 2 years.

1638 Localization of prospective areas in the blastoderm of the pea beetle, Callosobruchus maculatus fabr., as determined by ultraviolet (2573 A) irradiation injury. Alfred Brauer. AECU-439(ORNL-364), Sept. 1, 1949. 43p.

Eggs of the pea beetle, have been treated with ultraviolet 2537 A at an intensity of 17.5 ergs/mm^2/sec to determine: (a) general susceptibility by stage to ultraviolet irradiation; (b) value of cleavage cells in embryonic organization; (c) localization of formative values of points and areas within the early blastoderm and in the embryonic plate. The following conclusions are reached: Susceptibility to irradiation increases directly by developmental stage of early development. These stages are, cleavage, blastoderm formation, axial development. In the first stage, irradiation short of destruction of the first cleavage cells results in deformed but organized and axiate embryos. This is interpreted to mean that embryonic organization does not rest in the cells per se, but in the egg as a whole and in the cytoplasmic cortex in particular. Target irradiation of the early blastoderm indicates that formative values of embryonic areas are principally located along and immediately to each side of a ventral median line. Supra- and suboesophageal ganglia arise from cells directly in the center of the ventral surface and all other ganglia from cells just posterior to this center. The capsular head, not including ganglia, originates from cells immediately anterior to this "center of development." In the embryonic plate, formative values are extended anteriorly and posteriorly along the median line. Supra- and suboesophageal ganglia are more widely spaced posteriorly along the ventromedial line. More specific values become attached to points laterial to it.

Injury to cleavage, blastodermal, and various tissue cells indicates that cellular degeneration proceeds as follows: (a) enlargement and pyknosis of chromosomal threads with enlargement of nucleus and cell; chromosomes appear ragged and mitotic figures have prominent spindles with granules located on the fibers; (b) continued pyknosis with peripheral clumping of chromatin; portions of, or entire nuclei tend to stain acidophilically, nuclei and cells divide atypically and spindles are not found; (c) vacuolation of nucleus occurs with a breakdown of nuclear membrane and cell. If susceptibility is registered differentially in the early tissues, its effects appear most pronounced in neuroblasts and in the formation of ganglia, and least in muscular differentiation. Possible causal relationship between parts of the embryo is shown in that severe injury to supra- and suboesophageal forming area registers a corresponding lack of development in the head capsule even though the latter area is unaffected by incident of scattered radiation. 13 references.

1639 Increased radioresistance of red bone marrow after anoxia. Jerome A. Schack and Robert C. MacDuffee. *Science 110*, 259-60(1949) Sept. 9.

One hundred and forty female mice were randomly distributed into two groups, one maintained at sea level as a control unit and the other exposed to a simulated altitude of 15,000 ft for 10-14 hr a day. Both groups were kept at 25-30° C; animals were sacrificed frequently and the marrow from the femurs was examined for erythroblasts and normoblasts which were counted together as an erythroid percentage of the total marrow cells; this percentage was 10.6% in the normal animals and 18.6% in the anoxic animals. Both groups were then exposed to 500 r of total-body x-irradiation from a 200-kv machine and maintained at sea level; the erythroid percentage was rapidly reduced in the first two days, followed by a rise from the fourth to the sixth day, and a fall until the ninth day for normal animals; the experimental animals were identical in their reaction except for the absence of the last stage. It is indicated that the hyperplasia of the red marrow produced by exposure to low oxygen tension increases the resistance of the erythroid elements of the mouse to subsequent exposure to x-radiations.

1640 The indirect effect of x-rays on the synthesis of nucleic acid in vivo. Barbara E. Holmes. *Brit. J. Radiology 22*, 487-91(1949) Aug.

The synthesis of thymo- and ribo-nucleic acid (in the Jensen rat sarcoma) was studied in irradiated tumors and in other tumors in an irradiated animal which were themselves not receiving irradiation. The directly irradiated tumors received a dose of 2,000 r, which was sufficient to produce regression in many cases. Radioactive phosphorus, P^{32}, was introduced intraperitoneally to measure the radiation effect on the nucleic acid synthesis as demonstrated by the inhibition of the uptake of P^{32}. The details and results of the various experiments undertaken are presented.

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Thymonucleic acid synthesis was reduced to about 25% of the normal in the screened tumor; the ribo-nucleic acid renewal was affected similarly, but to a much smaller extent. In animals killed 1 hr after irradiation, the direct and indirect effects of the radiations were large. When P^{32} was injected about 2 hr after irradiation and the animal killed 1 hr later, the ribo-nucleic renewal was nearly normal in all tumors; the thymo-nucleic synthesis of the screened tumor was nearly normal, and in the irradiated tumor was about 60% of normal. When injected at 4 hr after irradiation and killed 1 hr later, the thymonucleic synthesis was found to be proceeding at a normal rate. Counts indicate that the dose of x radiation used produces a considerable amount of abnormal mitosis, while no normal mitosis is taking place 5 hr after irradiation.

1641 Morphological and biological characteristics of x-ray induced transplantable ovarian tumors. Talia Bali and Jacob Furth. *Cancer Research 9*, 449-72(1949) Aug.

The results and data on a series of experiments investigating the transplantability and other characteristics of radiation-induced ovarian tumors are presented. Doses of 87-350 r produced tumors of five types which were transplanted in series: granulosa tumors, luteomas, tubular adenomas, sarcomas, and angioendotheliomas. After a few transplantations each strain had certain definite morphological characteristics which remained fixed. In the genesis of these tumors two main forces were postulated: the direct or delayed x-ray effect, and a hormonal "imbalance" factor. In conclusion, it is stated that both factors require a more precise analysis to determine the sequence of events initiated by irradiation of the ovaries. 23 references.

1642 Radioactive substances act, 1948. London, H. M. Stationery Office, 1948. 12p.

This act covers the powers of the British Minister of Supply in relation to radioactive substances, the control of importation and exportation of radioactive substances, control of sale and supply of radioactive substances, control of use of irradiating apparatus for therapeutic purposes, safety regulations for occupations involving radioactive substances and irradiating apparatus.

1643 Treatment of radio-necrosis by the application of aluminum sheets. Giulio Tori. *Boll soc. ital. biol. sper. 25*, 74-6(1949) Jan. - Feb. (in Italian).

Nine cases were treated and consisted of two radio-necroses of the tongue, two of the sublingual region, one of the internal cheek, one of the skin of the neck, one of the skin of the abdomen, one of the skin of the elbow, and one of the skin of the popliteal hollow. The treatment usually lasted from 15-20 days to 40-50 days (resistant cases were treated longer) and consisted of the application of aluminum sheets or powdered aluminum to the necrotic ulcers. The results are considered satisfactory and the author encourages its further use in the cure of similar radiolesions.

1644 The effect of vitamin B_{12} on the leukopenia induced by radiation. Robert E. Carter, Elizabeth Busch, and Verda Strang. AECU-416 (LADC-694) nd. 14p.

Crystalline vitamin B_{12} administered via intramuscular injection, in single and in multiple doses, produced no effect on the leukopenia induced in rats by 400 r of 250 kv x-rays. 17 references.

1645 Cysteine protection against x irradiation. H. M. Patt, E. B. Tyree, R. L. Straube, and D. E. Smith. *Science 110*, 213-14(1949) Aug. 26.

Some observations concerning the influence of cysteine and cystine on the radiosensitivity of rats are reported. Brief exposures to intense irradiation were employed and the radiation factors were a 250-kv machine delivering radiations through 0.5 mm Cu and 3.0 mm Bakelite filters at a target distance of 27.5 cm and at a dosage rate of 210 r/min. Male and female rats weighing 150-250 g received 800 r of total-body x-radiation in a single exposure. Cysteine was injected into the tail vein 1 hr before, 5 min before, or 5 min after the exposure. Four different doses of cysteine were compared (175, 350, 575, and 875 mg of cysteine/kg body weight), and a 20% solution was used, the cysteine being injected slowly over a period of minutes; irradiated controls were injected with an equivalent volume of saline solution. The results show that pretreatment with cysteine markedly reduced the toxicity from total-body x-irradiation since there was an 82% survival from the treated group as compared with a 19% survival from the controls. Cystine, however, did not influence the survival rate. There were variations in the degree of protection per gram of cysteine depending on the pH of the administered solution; the injection of cysteine immediately after exposure was ineffectual. It is concluded that cysteine, but not cystine, administered to rats prior to x-irradiation in the nearly completely lethal range, greatly diminishes toxicity.

BIOLOGY AND MEDICINE (continued)

1646 The radioautographic technique. Dorothy J. Axelrod. Isotopes Division Circular IDA-4 (University of California). Jan 1948. 23p.

The following four general types of radioautographs are described: whole tissue or gross autographs, histological sections in contact with a photographic plate or film, histological sections covered with a photographic emulsion, and histological sections mounted on photographic plate or film. General problems in handling tissues and in making autographs are reviewed. 40 references.

1647 The control of polycythemia by marrow inhibition. John H. Lawrence. AECU-456 (UCRL-410), Aug. 9, 1949. 26p.

Polycythemia vera has been considered a fatal disease with a relatively short duration of life after onset, although an unusually long duration has been observed in some cases. In the true form of polycythemia the usual duration even after diagnosis, which is usually not established for over a year, is a number of years. Symptomatic relief and control of the hematologic picture have been possible in many patients by means of venesections, phenylhydrazine given orally, or roentgen irradiation, but there has been reported no large series of patients treated and observed for a long period in which evidence has been presented that there has been satisfactory control of the disease and marked lengthening of life. In the absence of methods for preventing the disease, it has been necessary to investigate methods of keeping the number of red blood cells normal or near normal. In 1938, after extensive animal and clinical studies with radioactive phosphorus, it was found possible to give nonlethal doses of sodium radiophosphate to animals and cause inhibition of cell production in the marrow (Lawrence and Scott, *Proc. Soc. Exper. Biol. & Med. 48*, 155-158(1941) Oct.). The phosphate containing P^{32} (half-life approximately 2 weeks) localized to a marked degree in bone, bone marrow, and rapidly growing tissue such as leukemic tissue. This paper attempts to evaluate the new therapeutic technique with relation to life expectancy or prolongation of life, by means of case histories of 172 patients suffering from polycythemia from various causes. P^{32} therapy was given to 121 patients and complete follow-up records kept on 118 of these. Significant observations are discussed. From vital statistical data it can be seen that at the present time patients with polycythemia vera properly treated have as favorable an outlook as do patients with diabetes mellitus treated with insulin or those with pernicious anemia treated with liver. An extensive bibliography is included.

1648 Cancer of the lip. D. Agostini. *Radioter. radiobiol. fis. Med. 2*, 92-111 (1949) (in Italian).

The results of the treatment of 302 cases of cancer of the lip and 27 pre-cancerous lip lesions by radium therapy are presented. The lip regions treated were the upper, the lower, and the labial junction. Primary lesions were treated with applications of interstitial radium in 2 mg needles with 1 mm Pt filters, and doses usually consisted of 3-4 to 16-20 mcd. A molded apparatus, filled with 10 mg radium charges located at 14-16 foci, was usually used in the therapy of metastatic lesions; the distribution of the foci was such as to produce uniform irradiation of the area. A 2 mm filter was placed in the system, and the radiations were transmitted at a 3 cm focal distance. There was a combined 76% -three-year cure rate for both the gangliary metastases and primary lesion cases. It is concluded that the methods presented here are advantageous for the treatment of lip carcinoma cases. 52 references.

1649 Experimental study of the influence of general irradiation by x-rays on a transplantable rat chloroma. Guérin. *Bull. Cancer. 36*, 71-6(1949)(in French).

Two experiments are described which were developed to determine the effects of x-rays on animals before and after the implantation of rat chloroma. The first experiment consisted of 115 rats which were uniformly irradiated with a single 600 r dose 24 hr before the chloroma transplantation; of these, 40% developed tumors, as compared to 33% for the nonirradiated controls. The average time period from transplantation and irradiation to death was lowered 28 days for the experimental animals from that of the controls who survived an average of 94 days. A diffuse infiltration of the hematopoietic organs and hemorrhage were also seen in some of the experimental rats. The second experiment consisted of irradiating with 600 r or 200 r, rats which had been implanted with chloroma tumors two to three weeks beforehand. The 200 r x-radiations seemed to have the beneficial effect of causing the chloroma to regress, while the 600 r administration caused an aggrevation of the tumor condition; the latter type of radiation also caused the

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appearance of the infiltration of the hematopoietic organs. It is concluded that x-rays act not only on the developing tumor, but also on the production of leukemic-like manifestations. 19 references.

1650 References on therapeutic and tracer uses of I^{131}. Isotopes Division Circular ILD-3. Nov. 1947. 8p.

A bibliography of 56 references from 1938 to 1947 inclusive has been compiled.

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1651 Adsorption of nitrogen tetroxide on silica gel. S. J. Birstein and A. M. Lyon. AECU-438(ARSC-30), Aug. 31, 1949. 13p.

Adsorption isotherms for N tetroxide on various silica gels have been determined at temperatures ranging from -20 to 20°C. The isotherms obtained for three commercial gels showed that total adsorption is independent of temperature and that low pressure adsorption increases greatly with decreasing temperature. Two gels prepared in the laboratory gave S-shaped adsorption isotherms in the high pressure regions, probably as a result of capillary condensation in their larger pore volumes. No correlation was found between the bound water contents of the gels and their adsorption isotherms.

1652 Krypton: a compendium of the literature. F. E. McKenna. AECU-453(ARSC-27), Sept. 2, 1949. 346p.

Abstracts of papers dealing with the preparation, properties, and uses of krypton have been assembled to provide easier access to the original literature. Krypton has been assigned a series of numbers in a decimal system which permits further work on the literature of the other rare gases to be added in a parallel arrangement. The abstracts of papers dealing with one subject, i.e., rectification, breakdown potential, isotopic abundance, etc., are grouped together; if an individual paper deals with more than one property of krypton, the abstract or the pertinent parts thereof appear in each of the sections. *Chemical Abstracts* was the prime source for this survey; in addition, *British Chemical Abstracts* and the *Journal of the Society of Chemical Industry* have been utilized. In many cases the original abstract has been edited, either to remove extraneous material or to amplify the abstract with additional information gained from the original papers.

1653 Distribution of radium between the fused mass of isomorphic salts and their crystals. V. G. Khlopin and V. R. Klokman. *Izvest. Akad. Nauk. S.S.S.R., Otdelenie Khim. Nauk.* 254-62(1949) May-June (in Russian).

The distribution of radium was studied between the fused mass of the following isomorphic salts and their crystals: barium nitrate, lead nitrate, lead sulphate, and strontium nitrate. It was found that in all cases the distribution follows the Berthelot-Nernst law. The distribution coefficient in these systems is less than one, or equal to one, which shows that, at temperatures of the order of 300-400°, the fused mass is enriched in radium, or, in other cases, the microcomponent is distributed about equally between the fused substance and the crystals.

1654 Special materials bulletin No. 5; metal-surfaced plywood. B.H.Webb. AECU-383 (KAPL-P-217), July 19, 1949. 8p.

Almost all Atomic Energy Projects have been faced with the problem of proving walls, wall-linings, and partitions in laboratory, shop, and production type buildings, which can withstand contamination or corrosion resulting from decontamination, as well as harmful effects from common acid or solvent fumes. Standard factory or office-type partitions composed of sheet steel with a baked enamel finish have answered most purposes, but are not fully satisfactory either by reason of design, cost, or durability. Some answer to the problem now appears to be available in stainless-surfaced plywood, in particular a product trade-named "Armorply". The material is manufactured by United States Plywood Corporation and is available in a wide variety of dimensions and specifications. Any thickness of sheet metal can be bonded to any standard thickness of sheet plywood, and the bond is so strong that the metal cannot be separated without destruction of the adjacent wood fibre. The flat dimensions of such sheets are limited only by the flat dimensions of the metal sheet to be bonded, and standard plywood lengths of 8, 10, or 12 ft can be supplied up to 36 in. wide when faced with .010 stainless steel and up to 48 in. wide with .0186 stainless steel. All varieties of finish available in sheet metal can be applied.

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Material and fabrication costs are summarized and methods of fabrication described. Several uses for which the material seems to be especially adapted are suggested.

1655 An "opener-upper" for gas samples. Francis J. Norton. *Rev. Sci. Instruments 20*, 620(1949) Aug. (Laboratory and shop note).

By using spherical ground glass joints, available commercially, a device can be made for admitting a gas sample sealed in glass into a vacuum system. The gas holder is simply a length of glass tubing, sealed at each end. It is scratched with a file or Carboloy scratcher at a suitable point, and placed in the ball-joint container. The whole is then put on a vacuum system by the tapered joint, or sealed on, and the outer container evacuated around the gas sample tube. Then when suitable vacuum is attained, the gas tube is broken by moving the lower ball-joint section.

1656 Analytical chemistry of the Manhattan Project. NNES Div. VIII, Vol. 1, Chap. 2. Thorium. C. J. Rodden and J. C. Warf. AECD-2701, nd. Decl. Jan. 26, 1949. 83p.

In this chapter the general chemistry of thorium is briefly discussed with the greatest emphasis on analytical chemistry. Other sources of collected information on thorium are listed in the bibliography. In general, the analytical chemistry is not as complicated nor as fully developed as in the case of uranium. The methods of separating thorium are discussed at some length; these include precipitation, formation of various complexes, volatilization, and resin column absorption. The determination of thorium by gravimetric, titrimetric, and colorimetric means is discussed. 107 references.

1657 Note on reagent for oxidation of carbon monoxide. William G. Smiley. AECU-417 (LADC-691) nd. 3p.

This document is not an abstract; it is reproduced below in its entirety.

In the determination oxygen in metals by vacuum fusion or in organic compounds by pyrolysis and reduction with carbon, carbon monoxide is the primary product, followed by conversion to carbon dioxide. In the vacuum fusion method this is accomplished by circulating the gas over hot cupric oxide, a rather slow process. In the organic oxygen method hot iodine pentoxide is used, and either the carbon dioxide or the iodine may be determined. It appears that little attention has been given in this country to a reagent, discovered by Schutze (*Ber. 77B*, 484(1944)), which oxidizes carbon monoxide to carbon dioxide instantly, at room temperature, and without liberation of other vapors, so that the carbon dioxide may be determined by condensation or absorption without further treatment. Schutze's reagent is a fine yellow powder prepared by heating a mixture of powdered silica gel, iodine pentoxide, and sulfuric acid at 220°C in a slow stream of dry air at reduced pressure. It oxidizes carbon monoxide (also ethylene and hydrogen sulfide) with formation of iodine which is completely retained and appears as a brown stain. The reagent prepared in this way, however, has the disadvantage of offering excessive resistance to gas flow, especially at low pressures. This note is to describe a modified form of Schutze's reagent which has the same chemical properties, but is coarse enough to permit rapid gas flow. The modified reagent was prepared as follows: A solution of 5 g of iodine pentoxide in 25 ml of water was mixed with 50 g of coarse (6-16 mesh) silica gel (much shattering of the grains of gel occurs at this point.) The mixture was dried at 145°C for about 1.5 hr and then wet with 10 ml of concentrated sulfuric acid. After standing overnight to insure uniform mixing, the material was sifted, the small portion that passed a 40-mesh screen was discarded. The remainder was placed in a glass combustion tube and heated in a furnace to 220°C in a slow stream of air at 1-2 cm pressure. Both ends of the tube were packed with silica gel, to dry the entering air and to retain the sulfuric acid and iodine evolved from the mixture. Heating was continued about 4 hr. The finished product resembles coarse yellow sand. An important point in the preparation is that the active compound must not be formed until all water has been removed, as it hydrolyzes very easily, liberating iodine. For the same reason, the finished reagent should be exposed to the air as little as possible. The reagent is conveniently used in a tube 10 mm in diameter. When a gas containing about 0.1 mg of carbon monoxide was passed through such a tube, the first few centimeters of the reagent were stained brown by the liberated iodine. The color deepened with the oxidation of further portions of carbon monoxide, but did not extend through the rest of the reagent. As pointed out by Schutze, the gradual extension of the stained area gives an indication of the degree of exhaustion of the reagent, which need not be renewed until only a small portion of the original yellow

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remains. The efficiency of the modified reagent was determined by condensing and measuring the carbon dioxide. Samples of a few tenths of a milligram of carbon monoxide were recovered as carbon dioxide with an accuracy of about 2%. The reagent is, therefore, suitable for use in microanalysis.

1658 The determination of oxygen in bismuth and other metals. Earl S. Funston and S. A. Reed. NEPA Division Report NEPA-1097. Aug. 3, 1949. 8p.

A method is presented for quantitatively measuring traces of oxygen in bismuth, arsenic, and other metals whose oxides are reduced by hydrogen in the temperature range 200-900°C. An indirect determination is made by measuring the volume loss of hydrogen after reduction of the metal oxides in a closed system. Amounts of oxygen from 2-500 ppm can be determined with an absolute error of ±1%.

1659 Carrier-free radioisotopes from cyclotron targets. I. Preparation and isolation of Sn^{113} and In^{114} from cadmium. Roy D. Maxwell, Herman R. Haymond, Donald R. Bomberger, Warren M. Garrison, and Joseph G. Hamilton. AECU-426 (UCRL-403), Aug. 11, 1949. 4p.

This is not an abstract; the document is reproduced below in its entirety.

The cyclotron is the only practical source of many carrier-free radioisotopes. The preparation and radiochemical isolation of a number of these activities, produced in the 60-in. cyclotron of Crocker Laboratory, will be presented in this paper and in subsequent papers of this series. In most cases the carrier-free radioisotopes were prepared for use in biological systems, and the final preparations were in the form of isotonic saline solutions at a range of pH from 5 to 8.

The present paper reports the radiochemical isolation of carrier-free Sn^{113} and In^{114} produced by bombarding cadmium with 38-Mev alpha particles. At this energy, Sn^{113} and In^{114} are produced in a thick target by the nuclear reactions $Cd^{110}(\alpha,n)Sn^{113}$; $Cd^{111}(\alpha, 2n)Sn^{113}$; $Cd^{112}(\alpha,3n)Sn^{113}$; $Cd^{111}(\alpha,p)In^{114}$; $Cd^{112}(\alpha,pn)In^{114}$ (G. T. Seaborg and I. Perlman, *Rev. Mod. Phy. 20*, 585(1948)). The shorter-lived tin and indium activities together with the possible radioisotopes of silver produced by (n,p) reactions, were allowed to decay out prior to the chemical separations.

The target, a block of C. P. cadmium metal, soft soldered to a water-cooled copper plate, was bombarded with 38-Mev alpha particles for a total of 450 μa-hr at an average beam intensity of 3.4 μa. After aging for one week, the bombarded surface was milled off and dissolved in a minimum volume of 16 N HNO_3.

0.2 g of target cadmium nitrate was dissolved in 25 ml of water, and the tin and indium activities were carried quantitatively on 10 mg of $Fe(OH)_3$ precipitated with NH_4OH. The $Fe(OH)_3$ was dissolved in 15 ml of 36 N H_2SO_4 and transferred to an all-glass distilling flask. (J. A. Scherrer, *J. Research Natl. Bur. Standards 21*, 95(1938)); J. Schwaibold et al, *Biochem. Z. 306*, 113(1940)). 9 N HBr was added dropwise while a stream of CO_2 was bubbled through the solution at 220°C. The distillate, containing the carrier-free Sn^{113}, HBr, Br_2 and traces of H_2SO_4 was caught in a series of traps filled with 12 N HCl; the indium activity remained in the residue. Carrier-free radio-tin collected in HNO_3 or H_2SO_4, forms a radiocolloid (O. Hahn, *Applied Radiochemistry*, Ithaca, N. Y., Cornell University Press, 1936) and is adsorbed onto the walls of the containing vessel. 12 N HCl keeps the radio-tin in solution presumably as the chlorostannate complex. The trap contents were treated with 5 ml of 16 N HNO_3 to destroy HBr, 15 mg of citric acid were added and the solution was evaporated on a steam bath to the 1-2 ml volume of H_2SO_4 carried over in the distillation. Citric acid prevents the formation of radiocolloid after removal of HCl.

The H_2SO_4 solution was diluted with 25 ml of water and the radio-tin was carried down on $Fe(OH)_3$ precipitated with NH_4OH. The $Fe(OH)_3$ was dissolved in 8 N HCl and iron was extracted with isopropyl ether. The aqueous phase, containing HCl, Sn^{113} and equilibrium amounts of the In^{113} daughter, was evaporated to dryness on 10 mg of sodium citrate. The activity dissolved quantitatively in distilled water.

The carrier-free Sn^{113} was identified by its 105-day half-life and by the 0.39-Mev conversion electron of the In^{113} daughter (S.W. Barnes, *Phys. Rev. 56*, 414(1939)). The indium fraction from a chemical separation of an equilibrium mixture using tin and indium carriers, showed the 105-min period of In^{113}.

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The residue from the tin distillation, containing Fe^{+++} and In^{114}, was neutralized with NH_4OH. The $Fe(OH)_3$ plus indium activity was dissolved in 8 N HCl, and extracted with isopropyl ether. The HCl solution of In^{114} was evaporated to dryness on 10 mg of NaCl. The activity dissolved quantitatively with the addition of distilled water. The In^{114} was identified by the assigned 48-day half-life and by the 0.19-Mev conversion electron (S. W. Barnes, *Phys. Rev. 56*, 414(1939); J. L. Lawson and J. M. Cork, *Phys. Rev. 57*, 982(1940)).

1660 Carrier-free radioisotopes from cyclotron targets. II. Preparation and isolation of Cd^{109} from silver. Roy D. Maxwell, Herman R. Haymond, Warren M. Garrison, and Joseph G. Hamilton. AECU-427(UCRL-404), Aug. 11, 1949. 3p.

This is not an abstract; the document is reproduced below in its entirety.

The radionuclide, Cd^{109}, produced by the nuclear reaction Ag^{109}(d,2n) (A. C. Helmholtz, *Phys. Rev. 70*, 982(1946)), has been isolated without added isotopic carrier by a solvent-extraction procedure based on the selective solubility of cadmium pyridine thiocyanate in chloroform. Radioactive palladium, 13-hr Pd^{109}, produced by the reaction Ag^{109}(n,p), was allowed to decay out prior to the separation of 185-day Cd^{109}. This activity, however, is not extracted with cadmium and the method may be used in isolating 6.7-hr Cd^{107} from an unaged target.

The target was a block of spectrographically pure silver (1/4 in. thick), soldered to a water-cooled copper plate. It was bombarded with 19-Mev deuterons for a total of 100 μamp-hr in the 60-in. cyclotron at Crocker Laboratory. The bombarded surface of the silver was removed from the target by milling off to a depth of 1/8 in.

The silver turnings were dissolved in a minimum volume of 16 N HNO_3 and the solution was evaporated to dryness on a steam bath. The $AgNO_3$ plus activity was dissolved in 25 ml of H_2O and the silver was complexed with excess NH_4CNS. The solution was adjusted to pH 5 with sodium acetate and the Cd^{109} was extracted with chloroform containing 5% pyridine. This procedure, originally developed (H. Fischer and G. Leopoldi *Mikrochim. Acta 1*, 30 (1937)) for the separation of micro amounts of cadmium, quantitatively extracted Cd^{109} from solutions containing presumably less than 10^{-8} g of stable cadmium.

To remove traces of silver, the chloroform phase was evaporated to dryness in a steam bath, redissolved in 2-3 ml of 1% H_2SO_4, and extracted with .005% dithizone in chloroform (E. B. Sandell, *Colorimetric Determination of Traces of Metals*, New York, Interscience Publishers, 1944). The final solution of Cd^{109} contained less than one μg of silver.

A small portion of the activity was added to a solution containing silver and cadmium in carrier amounts, and the silver was precipitated as AgCl; 99% of the activity remained in the supernatant.

Absorption measurements in aluminum showed conversion electrons of approximately 0.1 Mev and the 22-Kev x-ray of the Ag^{109} daughter. These data agree with the previously reported values (A. C. Helmholz *Phys. Rev. 70*, 982 (1946)).

1661 Carrier-free radioisotopes from cyclotron targets. III. Preparation and isolation of $Sb^{122, 124}$ from tin. Roy D. Maxwell, Herman R. Haymond, Warren M. Garrison, and Joseph G. Hamilton. AECU-428(UCRL-405), Aug. 11, 1949. 3p.

This is not an abstract; the document is reproduced below in its entirety.

Deuteron bombardment of tin produces $Sb^{122, 124}$ by the nuclear reactions Sn^{122}(d,2n)Sb^{122}, Sn^{124}(d,2n)Sb^{124} (J. J. Livingood and G. T. Seaborg, *Phys. Rev. 55*, 667(1939)). The present paper reports a carrier-free method of isolating these activities from the target element and from the radioisotopes of indium (n,p) and cadmium (n,α) which are formed concurrently by secondary neutrons produced by the 19-Mev deuteron beam of the 60-in. medical cyclotron at Crocker Laboratory. Other possible (G. T. Seaborg and I. Perlman, *Rev. Mod. Phys. 20*, 585(1948)) shorter-lived radioisotopes of antimony were allowed to decay out prior to the chemical separation.

The target was a block of C. P. tin, soft soldered to a water-cooled copper plate. It was bombarded with 19-Mev deuterons for a total of 83.1 μa-hr in the 60-in. cyclotron at Crocker Laboratory. The bombarded surface was removed by milling.

0.5 g of turnings were dissolved in a minimum volume of aqua regia. 12 N HCl was added to destroy excess HNO_3 and the solution was diluted to approximately 25 ml of 0.1 N HCl. 10 mg of cadmium were added and precipitated with H_2S after addition of 1 gm of oxalic acid to prevent (F. P. Treadwell and W. T. Hall, *Analytical Chemistry Vol. II*, New York, Wiley, 1942) precipitation of tin sulfide. The antimony activity carried quantitatively. The CdS was dissolved in

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HCl plus oxalic acid, reprecipitated with H_2S, dissolved in a minimum volume of 12 N HCl, and transferred to an all-glass distilling flask (J. A. Scherrer, *J. Research Natl. Bur. Standards, 21*, 95(1938)). 15 ml of 60% $HClO_4$ were added and traces of tin were distilled (W. Rall and R. G. Wilkinson, *Phys. Rev. 71*, 321(1947)) at 200°C during the gradual addition of 10 ml of 12 N HCl. Approximately 98% of the carrier-free antimony remained in the residue. The antimony activity was then distilled with the gradual addition of 10 ml of 40% HBr. The distillate contained 95% of the $SB^{122, 124}$. Indium and cadmium were retained in the residue.

To obtain carrier-free radio-antimony in isotonic saline for subsequent biological investigation, the distillate was treated with aqua regia to destroy HBr and evaporated to dryness on 40 mg of NaCl. The activity dissolved quantitatively with the addition of 5 ml of distilled water.

The decay curve was followed for 300 days and showed two periods: 2.8-day Sb^{122} and 60-day Sb^{124}. One month after bombardment, the activity contained only 60-day Sb^{124}; mass absorption measurements in Pb showed the 1.7-Mev gamma ray previously reported (W. Rall and R. G. Wilkinson, *Phys. Rev. 71*, 321(1947)). A tracer amount of carrier-free antimony was added to a solution containing milligram amounts of tin, antimony, and indium; the antimony fraction was separated chemically (F. P. Treadwell and W. T. Hall, *Analytical Chemistry Vol. II*, New York, Wiley, 1942) and contained 98% of the activity.

1662 Carrier-free radioisotopes from cyclotron targets. IV. Preparation and isolation of Mn^{54} and $Co^{56,57,58}$. Roy D. Maxwell, Jeanne D. Gile, Warren M. Garrison, and Joseph G. Hamilton. AECU-429(UCRL-417), Aug. 17, 1949. 3p.

This is not an abstract; the document is reproduced below in its entirety.

Carrier free radioisotopes of manganese and cobalt of useful half-life may be obtained only cyclotron bombardment. The present paper describes chemical methods of isolating Mn^{54} and $Co^{56,57,58}$ from an iron target bombarded with 19-Mev deuterons in the 60-in. cyclotron at the Crocker Laboratory. At this energy Mn^{54} and $Co^{56,57,58}$ are produced in a thick target by the nuclear reactions (G. T. Seaborg and I. Perlman, *Rev. Mod. Phys. 20*, 585 (1948)): $Fe^{56}(d,\alpha)Mn^{54}$, $Fe^{56}(d,2n)Co^{56}$, $Fe^{56}(d,n)Co^{57}$, $Fe^{57}(d,2n)Co^{57}$, $Fe^{57}(d,n)Co^{58}$. Other possible shorter-lived radioisotopes of manganese and cobalt were allowed to decay out prior to the separation.

The iron target was silver soldered to a water cooled copper probe and bombarded for 2000 μamp-hr at an average beam intensity of approximately 50 μamp. The bombarded surface was dissolved off in 6 N HCl.

All but approximately 10 mg of the target iron was extracted with ether. The aqueous phase was neutralized with NH_4OH, a few drops of bromine were added, and $Fe(OH)_3$ was precipitated with 15 N NH_4OH in excess. Under these conditions carrier free radiomanganese was quantitatively carried, presumably in the quadrivalent state. Over 98% of the radiocobalt remained in the supernatant (E. G. Ardagh and G. R. Bongard, *J. Ind. Eng. Chem. 16* 297 (1924)). The $Fe(OH)_3$ plus radiomanganese was reprecipitated twice with Br_2-NH_4OH in the presence of 1 mg of cobalt hold-back carrier. Three additional precipitations removed traces of carrier cobalt. The $Fe(OH)_3$ was washed, dissolved in 6 N HCl and iron was extracted with ether. The solution of carrier free radiomanganese in 6 N HCl was evaporated to dryness after the addition of 5 ml of isotonic saline solution. Addition of 5 ml of distilled water gave an isotonic solution of carrier-free Mn^{54} for subsequent biological experiments.

The activity was identified by the 310-day half-life and by the 0.85-Mev gamma ray reported (J. J. Livingood and G. T. Seaborg, *Phys. Rev. 54*, 391 (1938)) for Mn^{54}. As further identification, a small amount of activity added to a solution containing carrier amounts of Mn, Fe, and Co was quantitatively recovered in the Mn fraction from a chemical separation (F. P. Treadwell and W. T. Hall, *Analytical Chemistry, Vol. 1*, New York, Wiley, 1942).

The supernatant from the first $Fe(OH)_3$precipitation containing carrier-free radiocobalt, NH_4OH was evaporated to dryness and treated with 16 N HNO_3 to destroy ammonium salts. 12 N HCl was added to remove HNO_3 and the solution was evaporated to dryness on 40 mg of NaCl. The activity dissolved quantitatively in 5 ml of water.

The radiocobalt showed the 72-day half-life of $Co^{56,58}$; after 200 days the longer period of Co^{57} was apparent. In addition, chemical separation with added Mn, Fe, and Co carriers identified the activity as cobalt. Mass absorption measurements showed the 1.2-Mev beta reported (J. J. Livingood and G. T. Seaborg, *Phys. Rev. 60*, 913 (1941)) for Co^{56}. The combined gamma radiation had a half-thickness of approximately 10 gm/cm^2 in lead.

CHEMISTRY (continued)

1663 The anion-exchange separation of ribonucleotides. Waldo E. Cohn. AECU-430 (ORNL-285), Aug. 29, 1949. 27p.

Investigations of nucleic acid chemistry, constitution, and metabolism, particularly where tracers are employed, depend to a great degree upon the development of methods for the quantitative separation of the various chemical and enzymatic degradation products of the larger molecules. For greatest usefulness, these methods should be operable at the lowest detectable levels of concentration and amount of material and they should give adequate resolution - complete, if possible - of closely related substances. Previous work in the development of ion-exchange procedures led to the choice of ion-exchange as a likely mechanism to exploit in order to develop better separation methods for the nucleotides, nucleosides, and free bases. The nucleotides of ribonucleic acid have been separated from each other and from the corresponding free bases and ribosides by successive elution from strong base anion-exchangers with weak acids and buffers of controlled pH and anion concentration. The order of elution at pH 2 is cytidylic, guanylic and uridylic acid; at pH 2.5 – 3, uridylic precedes guanylic acid; at pH 5.5, uridylic and cytidylic are removed together as are adenylic and guanylic acid. In all cases, the bases and ribosides precede cytidylic acid and may be separated from each other as well as from the nucleotides during the procedure. The three isomers of adenylic and of inosinic acids may be separated. The applications of this technique to analysis, isolation, investigation, and manufacture are indicated. 19 references.

1664 The separation of traces of sodium from a weighable quantity of magnesium. Robert Bouchez and Georges Kayas. *Compt. rend. 228*, 1222-3(1949) Apr. 4 (in French).

In order to prepare a radioactive source of Na^{22} of high specific activity, a ribbon of Mg was bombarded with deuterons and the Na^{22} obtained from the reaction $Mg^{24}(d,\alpha)Na^{22}$ was separated from the Mg using the ionographic method. Complete separation of the Na^{22} was obtained using a 10-g column of synthetic resin (Amberlite IR-100) on which the mixture to be separated was adsorbed (in the state of chlorides of pH approximately 7 and 20 cc volume). In making the extraction from the mixture it was found that .1 N perchloric acid was more satisfactory than .1 N HCl.

1665 The action of x-rays on solutions containing iron: some new results. Norman R. Todd and S. L. Whitcher. AECU-458(UCLA-34), Aug. 5, 1949. 33p.

A spectrophotometric method of analysis for ferric iron based on the color produced by the addition of potassium thiocyanate has been developed. Using the oxidation of ferrous iron solutions by x-rays as an indicator, this method has been applied to the determination of the ionic yield for x-rays as a function of solution concentration, radiation intensity, and action on the oxidized form. The following conclusions have been made from the experimental results: (1) the amount of chemical change is proportional to the energy absorbed by the solution, (2) the ionic yield increases slightly with increase in concentration and is 6.7 molecules per ion pair on the average, (3) the chemical change is essentially independent of x-ray intensity over a range of 50:1, and (4) the ferrous iron is completely oxidized by x-rays; any back reaction or reduction of ferric iron was not detected. 13 references.

1666 Nomograph of Hg 5461 structure as a function of etalon separation. J. R. McNally, Jr. AECU-461(Y-455), July 18, 1949. 6p.

A nomograph illustrating the structure of the 5461 A spectrum line of natural mercury as a function of the plate separation of a Fabry-Perot interferometer is presented and described.

1667 The synthesis of labeled alpha amino acids. James C. Reid and B. M. Tolbert. AECU-437(UCRL-408), Aug. 1, 1949. 28p.

The literature on the synthesis of isotopically labeled amino acids (both active and inactive isotopes) is reviewed, and a short comprehensive outline of the chemicals used is presented. The introduction of deuterium, tritium, N^{15}, C^{13}, C^{14}, S^{34}, S^{35}, and I^{131} into amino acids is discussed. 43 references.

CHEMISTRY (continued)

1668 Effect of chemicals on Fluorothene. S. E. Frey, J. D. Gibson, and R. H. Lafferty, Jr. AECU-441(K-475), Aug. 19, 1949. 48p.

The following A.S.T.M. tests were performed on Fluorothene sheets: water vapor permeability, water absorption, flammability, specific gravity, and chemical resistance. The tests of chemical resistance were greatly expanded to include approximately 125 reagents, tests at elevated temperatures, and for prolonged immersion times. Fluorothene has a specific gravity of 2.111 at 25°C, is self-extinguishing, has little or no water vapor permeability, and no water absorption. Fluorothene was found to be very resistant chemically and was not dissolved by any reagent at ordinary temperatures. However, certain reagents, especially those with low dielectric constants, are absorbed by the plastic, and this absorption is greatly facilitated by an elevation of temperature. The materials which gave the greatest changes were in the following classes: amines, chloro and chlorofluoro compounds, esters, ethers, and the element chlorine. In general, it may be said that as Fluorothene absorbs reagents and gains in weight, the flexibility and swelling of the sample increases. An orientation of the polymer chains in the sheets of Fluorothene is suggested by the different penetration rates along the various dimensions on certain samples.

1669 Fritted Fluorothene - a chemically inert filtration medium. W. H. Reysen, D. S. Napolitan, W. T. Daniel, and R. H. Lafferty, Jr. AECU-442(K-476) Aug. 19, 1949. 16p.

A method has been developed for forming Fluorothene (polychlorotrifluoroethylene plastic) into porous material suitable for both gas dispersion and filtration. Finely-divided Fluorothene powder was flamesprayed on a suitable base by means of a Schori pistol in such a manner that a porous multilayer of partially densified powder was obtained. Porous disks were prepared from this material by cutting and buffing to the desired dimensions. Techniques involving powder-rubbing, sintering, and cold-pressing were used to reduce the pore size and to increase strength and dimensional stability. Filtration discs as large as 16-in. in diameter and ½in. thick were prepared. These disks were not attacked by acids and most organic solvents at ordinary temperatures and were not wet by water. Some were fabricated which were almost shatterproof and all withstood a reasonable amount of flexing. The untreated flame-sprayed fritted material was used successfully to filter coarse precipitates and after suitable treatment to reduce the pore size precipitates as fine as barium sulfate.

1670 The problem of plutonium. Bertrand Goldschmidt. *Atomes*, 227-32(1949) July (in French).

The history of the discovery, isolation and the study of the production and chemical extraction of the element plutonium, particularly in relation to atomic piles, is discussed. 5 photographs.

1671 The chemistry of uranium. E. I. Rabinowitch and J. J. Katz. AECD-2667, n.d. Decl. Aug. 12, 1949. 570p. For publication in NNES, Div. VIII, Vol. 5, Part I, Chaps. 11-16. (See also NSA 3-680).

This report is a continuation of AECD-2664. It consists of the following:

Chapter 11, Uranium Oxides, Sulfides, Selenides, and Tellurides (phase relationships in the uranium-oxygen system; physical properties of anhydrous uranium oxides; phase relationships and physical properties in the uranium-oxygen water system; oxidation and reduction of uranium oxides and hydroxides; conversion of other uranium compounds to uranium oxides and hydroxides; conversion of uranium oxides and hydroxides to other uranium compounds; uranium-sulfur system; uranium selenides and tellurides)

Chapter 12, The Non-volatile Fluorides of Uranium (uranium trifluoride; uranium tetrafluoride; uranium pentafluoride and the intermediate fluorides, U_2F_9 and U_4F_{17})

Chapter 13, Uranium Hexafluoride (preparation of uranium hexafluoride; physical properties of uranium hexafluoride; chemical properties of uranium hexafluoride)

Chapter 14, Uranium-Chlorine Compounds (uranium trichloride, uranium tetrachloride, uranium pentachloride, uranium hexachloride)

Chapter 15, Bromides, Iodides, and Pseudo-halides of Uranium (uranium tribromide; uranium tetrabromide; uranium triiodide and uranium tetraiodide; mixed halides of tri- and tetravalent uranium; uranium borohydrides; uranium carbonyl)

Chapter 16, Oxyhalides of Uranium (uranyl fluoride; uranium(IV) oxyfluoride; uranyl chloride; uranium(IV) oxychloride; uranyl bromide; uranium(IV) oxybromide; uranyl iodide) Extensive references are included for each chapter.

ENGINEERING

1672 **Pressure loss in piping systems; a comparison of conventional factors for fluid friction in piping components.** R. H. Armstrong. AECU-454(ANL-HE-93), nd. 14p.

This report summarizes and compares data for the pressure loss coefficients due to friction in piping for sudden contractions, sudden enlargements, and 90° bends. A multiplication factor for determining the loss of bends other than 90° is given. Reduction of losses by use of properly designed 90° vaned elbows is discussed briefly. The density of helium at temperatures of 450°, 475°, 500°, 800°, 825° and 850°F for a pressure range of 1960 to 2030 psia is presented in an appendix. 13 references.

1673 Survey of pile-made isotopes for industrial radiography. W. F. Eastwood. Atomic Energy Research Establishment Report AERE I/R 386. July 1949. 12p.

The report reviews the work being done on the production of gamma sources for use in radiography. Requirements for sources, criteria for choice of isotopes, a table of suitable isotopes and their nuclear properties, applications and techniques for use of these sources, manufacturing methods, standardization, and shielding for handling and irradiation purposes are all discussed. A provisional list of prices for cobalt, tantalum, and iridium sources of varying strengths is included.

MINERALOGY, METALLURGY AND CERAMICS

1674 **Solubility relationships of the refractory monocarbides.** J. T. Norton and A. L. Mowry. Massachusetts Institute of Technology Technical Report No. 1. nd. 21p. (NP-902).

An investigation to examine the solubility of pairs of carbides of V, Ti, Cb, Ta, and Zr by heating the several pairs together until equilibrium was established and then examining the product by x-rays is reported. The following conclusions were reached. The monocarbides of the elements Ti, Zr, Va, Cb, and Ta are isomorphous and have a NaCl type structure. The binary carbide systems, TiC-ZrC, TiC-VC, TiC-CbC, TiC-TaC, ZrC-CbC, ZrC-TaC, VC-CbC, VC-TaC, CbC-TaC form continuous series of solid solutions. The binary carbide system ZrC-VC shows very small solubility, the limits at 2100°C being 5% at the Zr-rich end and less than 1% at the Va-rich end. The parameter-composition curves show only slight deviations from Vegard's Law but both positive and negative deviations are found. The maximum size difference between atom diameters expressed in percentage of the solvent atom diameter for extended solubility is 13%. The minimum value for very restricted solubility is 16%. In the solid solution, the metal atoms are distributed at random on the points of the metal lattice.

1675 Forced convection heat transfer theory and experiments with liquid metals. Richard N. Lyon. AECU-419(ORNL-361) Aug. 19, 1949. 109p.

A theoretical development is described which leads to the following equation for an ideal tubular system in forced convection: $$\frac{1}{Nu} = 2\int_0^1 \frac{\left[\int_0^{S_q} VSdS\right]^2}{S_q \frac{K}{k}} dS_q$$

Nu is the Nusselt modulus; V is the relative velocity; S, the relative distance from the center of the tube; k the molecular conductivity of heat; and K is the total conductivity (molecular plus eddy). This equation may be applied to any fluid in either turbulent or viscous flow. Application of the analogy between fluid friction and heat transfer leads to the equation:

$$\frac{1}{Nu} = 2\int_0^1 \frac{\left[\int_0^{S_q} VSdS\right]^2}{S_q\left(1+\alpha Pr\frac{\epsilon_M}{\nu}\right)} dS_q$$

where α is the ratio of the eddy diffusivities of momentum and heat; ϵ_M is the eddy diffusivity of momentum; Pr is the Prandtl modulus; and ν is the kinematic viscosity. This equation, when used with other experimental data, leads to numerical results which may be roughly generalized by the equation: $Nu = 7+0.025(\alpha Pe)^{.8}$ where Pe is the Peclet modulus. Similarly the theoretical results of Harrison and Menke for an asymmetrically heated parallel plate system are shown to approximate: $Nu = 4.9+0.0175\ (\alpha Pe)^{.8}$. Experiments with sodium-potassium alloy are described which appear to support these generalizations where the parallel plate equation is applied to narrow annuli and α is assumed to be unity.

MINERALOGY, METALLURGY AND CERAMICS (continued)

1676 Progress report for June 1949. Carl Moore, D. S. McKinney, and J. C. Warner. AECU-420 (CAR-202), July 1949. 7p.

The corrosion characteristics of the zinc-iron couple in 0.1 N sodium sulfate and in 0.1 N sodium sulfate plus sodium hydroxide to raise the pH to 8 have been studied. The pH of the corroding medium has been observed to increase with time with the exception of the vessels containing iron in which the initial pH was 7.7 or 9.5. A gas, probably hydrogen, was noted as a corrosion product. Plans for future experimental work on the zinc-iron couple and on the hydrogen overvoltage of titanium and zirconium are included.

1677 Molybdenum and tungsten: a survey of the literature. R. H. Greaves. Armament Research Establishment Great Britain Report ARE MR 1/49. nd. 17p.

A survey of the literature covering the sources, methods of extraction and production of molybdenum and tungsten has been made. The large ingots of fused ductile molybdenum now being produced in America by an arc casting method are considered. The physical and mechanical properties of the two metals are presented and in addition the report briefly surveys the theoretical considerations of the constitution of molybdenum-rich and tungsten-rich alloys. 76 references.

1678 Sheath working of metal powders. James R. Long and Earl T. Hayes. U. S. Bureau of Mines, Repts. Invest. 4464, Feb. 1949. 13p. (See also NSA 2-1584).

The Federal Bureau of Mines research program to develop ductile titanium has resulted in the development of a semi-commercial process for the preparation of the metal. The investigation concentrated on improving the technique for consolidation of titanium powder into solid nonporous metal. As a result the sheath rolling of green but unsintered powder-metal compacts, as well as rolling of loosely packed powder or mixtures of powders was undertaken. The results are summarized as follows: (1) Excellent consolidation was realized, even when the powder was not packed into the sheaths very densely. (2) Elimination of voids, in comparison to high-pressure compacting at room temperature followed by vacuum sintering, is impressive and deserves more detailed study. (3) The homogeneity of the sheath-rolled metal in comparison to pressed and sintered compacts was outstanding. (4) The rupture of oxide and other films on the surfaces of the powder particles is definitely shown, and the result was more effective welding together of the metal particles, leaving the remnants of film material as isolated inclusions. The kneading acting during rolling is believed to have provided this more effective means of ripping off films and permitting bare metal-to-metal contacts. (5) Separation of the final thinned-out sheath from the rolled, consolidated mass of metal was generally easier than was anticipated. The gases imprisoned with the metal powder were squeezed out of the compacted mass, leaving fewer perceptible voids.

1679 On the distribution of radioactive minerals in a granite. René Coppens. *Compt. rend. 228*, 1218-20(1949) Apr. 4 (in French).

The study, by means of a photographic plate, of the radioactivity of a Brittany granite, both of a pulverized sample and of a polished sample, has resulted in a complete determination of the radioactivity present. The ratio of the concentration of Th to that of U i.e., C_{Th}/C_U, was determined as approximately 2.8 using the relationship between the concentration of these elements and the number of β particles in a particular range which were detected. Using this ratio and measuring the average number of α particles emitted/cm^2/sec, the average activities were found to correspond to concentrations of the order of 10^{-5} of both metals. The lack of uniformity in the distribution of the radioactivity within the crystal is noted.

1680 Uranium resources. J. K. Gustafson. *Sci. Monthly 69*, 115-20(1949) Aug.

The following topics related to the general topic of "mineral resources" are treated: (1) the occurrence of uranium in nature; (2) the amount of uranium which is available for the expansion of the atomic energy program; and (3) the precautions being taken by this country to insure a continuing adequate supply of uranium. The author believes that the estimates of future uranium supplies which have been made are too pessimistic and concludes that there will be enough source material to permit the expanded use of atomic energy for several generations.

PHYSICS

1681 The age of the universe. Richard Chase Tolman. *Revs. Modern Phys. 21*, 374-8(1949) July.

The present status of the various methods of estimating the "age of the universe" are reviewed with the reservation that "age of the universe" merely refers to the estimated time back to some large-scale event for which it is believed evidence exists, rather than the assumption, necessarily, that at some earlier date the material universe did not exist. The methods which are of concern for estimating dates of past events are classified as follows: (1) the consequences of stellar interaction in our own galaxy, (2) the consequences of radioactive decay in terrestrial or meteoritic matter, and (3) the consequences of nebular recession. The calculations which have been made on the basis of the first two types of data are discussed and then considered in relationship to nebular recession.

1682 Cosmic abundances of nuclei and the natural β activity. Hans E. Suess. *Z. Physik, 125*, 386-393(1949) (in German).

Nuclear mass numbers, for which long-lived unstable isobars are known, usually present certain irregularities in the relative abundances of the nuclei. An explanation of this fact is sought for every particular case. Mass number 40: the abnormal abundance of A^{40} in the atmosphere is, of course, due to its formation from K^{40}. Mass number 87: the low abundance of this mass may be due to a neutron emission by primary nuclei rich in neutrons, with the formation of stable nuclei, at the time of the generation of the elements; this process is similar to the delayed neutron emission observed on nuclei of this mass number in certain fission reactions: as in the case of a long-lived β activity, neutron emissions of the kind described are to be expected in situations where the energy trough presents a well formed flat. Mass number 99: the abundances of masses 99 and 101 are below the normal by an amount equal to that by which the abundances of masses 98 and, respectively, 100 are above the normal; the neutron emission, discussed under mass number 87, seems to have occurred preferably with nuclei of odd mass numbers. Mass number 129: I^{129}, which, according to American authors, is a long-lived nucleus, must, in accordance with the statistics of abundances, have a half-life at least 10 times shorter than the time between the generation of the elements and the formation of the earth atmosphere. Mass number 176: the situation is similar to that of mass 87; however, the irregularities in the abundances of the neighboring heavy nuclei do not permit a reliable interpolation of abundance relationships. An experimental study on zircon showed that there is no long-lived β emitter among the isotopes of this element.

1683 Altitude dependence of penetrating particles slowed down after traversing 15 cm of lead. Marcello Conversi. *Phys. Rev. 76*, 851(1949) Sept. 15 (Letter to the editor).

In addition to the previously reported delayed coincidence measurements (*Phys. Rev. 76*, 849(1949)), anticoincidence measurements were taken simultaneously both with and without graphite absorber. Whereas at sea-level the number of "true anticoincidences" is given by the expression, $I_\alpha = (1\text{-}p)M$, in which M is the number of mesons stopped in the absorber per hour, at higher altitudes it is necessary to add a contribution X to the preceding equation. This represents the number of anticoincidences attributable to particles other than mesons. Tabulated values of X are given for different altitudes; the X-component is observed to exhibit a large latitude effect and an exponential increase with the altitude. Various arguments are advanced to support the view that the X-component if of nucleonic nature and consists for the most part of protons.

1684 Altitude dependence of mesons of energy between 224 and 255 Mev. Marcello Conversi. *Phys. Rev. 76*, 849-50(1949) Sept. 15 (Letter to the editor).

Further results (*Phys. Rev. 76*, 311(1949); *76*, 444(1949)) of a series of B-29 flights, recently undertaken to investigate the nature of the ionizing particles slowed down after penetrating a certain thickness of lead, are reported which were obtained by means of delayed coincidence measurements. Decay curves obtained at several altitudes are shown for mesons slowed down in 10 cm of graphite after traversing 15 cm of lead. Tabulated data are given on the number of mesons stopped in the absorber/hr as functions of the altitude (in the range 600-36,000 ft). From sea-level measurements the lifetime of the ordinary meson has been determined as (2.19 ± 0.07) μ sec. It is noted that all the disintegration curves are consistent with a decay constant of 2.2 μ sec and an analysis of the measurements made at 30,000 ft gives a value of (2.14 ± 0.12) μ sec for the decay constant.

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1685 Capture of negative mesons by atom nuclei in the light of a "pair" theory of nuclear forces. V. Lebedev and M. Markov. *Zhur. Eksptl. i Teoret. Fiz. 19*, 292-6(1949) Apr. (in Russian).

The capture of negative mesons by nuclei, described by Conversi, et al. (*Phys. Rev. 71*, 209(1947)) and by Sigurgeirsson and Yamakawa (*Phys. Rev. 71*, 319(1947)) takes place with probabilities that are 10^{10} to 10^{12} times higher than those calculated by assuming meson spins equal to 0 and 1 (Fermi, et al., *Phys. Rev. 71*, 314(1947)). It was also observed (Piccioni, *Phys. Rev. 73*, 411(1948)) that these captures are not accompanied by "stars," a fact that also can hardly agree with a theory of mesons of integral spins. These difficulties disappear in a theory of meson pairs where the spin of negative mesons is assumed to be equal to $\frac{1}{2} \cdot \frac{h}{2\pi}$ and the capture phenomenon explained by a mechanism of nuclear forces similar to that of β forces described by Ivanenko and Tamm (*Nature 133*, 981(1934)). It is found that a negative meson will be captured by the nuclei Fe^{56}, Al^{27}, and S^{32} with a probability exceeding that of a spontaneous meson disintegration in the energy range from -2 Mev to zero. Under the same conditions, captures by C^{12} and Be^{7} are absolutely forbidden. The value of the excitation energy is too low to produce "stars."

1686 Disintegration of heavy varitrons. A. I. Alikhanian, D. M. Samoĭlovich, I. I. Gurevich, and Kh. P. Babayan. *Zhur. Eksptl. i Teoret. Fiz. 19*, 667-70(1949) July (in Russian).

Some of the tracks, produced by cosmic rays in photo-emulsions and described by the authors in *Zhur. Ekxptl. i Teoret. Fiz. 19*, 664-6(1949), showed a secondary track. In one of the three cases of such disintegrations described here, the secondary track ends in the emulsion, thus permitting the determination of the mass of the secondary particle; this mass is about 200 m_e, that of the primary particle being 750-800 m_e. In another case the mass of the primary was 8,000-10,000 m_e. In the third case, both the primary and secondary particles have masses approaching that of the proton.

1687 Galactic rotation effect and the origin of cosmic radiation. M. S. Vallarta. *Revs. Modern Phys. 21*, 356(1949) July.

The work which has been done on the question of the origin of the primary cosmic charge particles, i.e., whether they come from outside our galaxy or not, is reviewed.

1688 Investigation of the interaction of the primary component of cosmic rays with matter in the stratosphere. S. N. Vernov. *Zhur. Eksptl. i Teoret. Fiz. 19*, 621-6(1949) July (in Russian).

Balloon measurements, up to 30 km altitude, showed that the soft component of cosmic rays in the stratosphere consists of electrons, while the study of the hard component and of the showers generated by the primary particles lead to the conclusion that an intensive electron-photon component is generated through the absorption of the primaries. If the generation of the penetrating component is due to a disintegration of short-lived mesons, the latter's half-life must be less than 10^{-10} sec.

1689 Investigation of the nature of particles in "peculiar" showers of cosmic radiation. N. Birger and L. Eidus. *Doklady Akad. Nauk. S.S.S.R. 65*, No. 6, 819-22(1949) Apr. (in Russian).

This article describes the methods used and the results of investigations on the nature of the particles generated in "peculiar" cosmic ray showers. The article lists the numbers of particles generated in various energy levels, with the exception of those whose impetus was in excess of 60 Mev. The following particles have been observed: photons, protons, particles with a mass less than that of protons, secondary mesons, and slow mesons. A diagram of the apparatus used in the investigation is included, as is also a Wilson chamber photograph showing the path of two particles.

1690 Models and methods in the meson theory. Hideki Yukawa. *Revs. Modern Phys. 21*, 474-9(1949) July.

The various meson-decay schemes which have been proposed are reviewed and evaluated. Some of the experimental data are discussed and the problems of the τ-meson and the neutral meson are considered. Present concepts of nuclear forces are discussed in relation to meson theory. It is noted that although the present status of meson theory represents a considerable improvement over that of a few years ago, several deficiencies exist since there is a lack of

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knowledge concerning (1) the fundamental law which determines the masses of various kinds of elementary particles and, (2) the reason for the stability of the whole system of elementary particles interacting and interchanging with each other. It is suggested that a broader background may be necessary for field theory (such as the five-dimensional space or the quantized phase space) in order to cope with the aforementioned problems.

1691 On the μ-meson capture. M. Taketani and M. Sasaki. *Phys. Rev. 76*, 852(1949) Sept. 15 (Letter to the editor).

Previously reported work (*Phys. Rev. 76*, 60(1949)) has been extended by considering the μ-meson capture process, first with respect to the Z-dependence of the capture probability, and secondly with respect to the excitation energy of the nucleus after the capture. The calculations made indicate that the total probability is roughly proportional to Z^4. Further calculations indicate that the average kinetic energy of the nucleon in the ground state is approximately 100 Mev. For large Z an excitation value of 6 Mev is obtained, whereas for small Z it is about 14 Mev. An interaction scheme for the interaction between elementary particles is shown which is in agreement with recent experiments at Berkeley.

1692 On penetrating showers in cosmic radiation. H. A. Meyer, G. Schwachheim, A. Wataghin, and G. Wataghin. *Phys. Rev. 76*, 598-601(1949) Sept. 1.

The mean range of the radiation that generates penetrating showers has been determined in the atmosphere and in water. The results are, respectively, $\sim$ 120 g/cm^2 and $\sim$ 55 g/cm^2. The relation between the observed variation of the frequency of penetrating showers with barometric pressure and the absorption law in air for the shower producing radiation has been discussed in some detail. The east-west asymmetry of the radiation that generates penetrating showers has been studied and the results were found to be negative within the experimental errors. The penetrating power of the penetrating showers produced in air has been investigated. No appreciable absorption has been found when the lead protection of the counters has been increased from 18 to 28 cm.

1693 On positive excess of meson component near sea level. P. Bassi, E. Clementel, I. Filosofo, and G. Puppi. *Phys. Rev. 76*, 854(1949) Sept. 15 (Letter to the editor).

Experiments were performed at sea-level in which the positive and negative mesons were separated by means of a magnetic field of 14,000 gauss in air. A diagram of the coincidence counting apparatus is shown and tabulated coincidence rates and positive excess values are given for lead absorber thicknesses of 290, 540, and 1,150 g/cm^2. The results obtained are in agreement with these of Nereson (*Phys. Rev. 73*, 565(1948)) Conversi, et al (*Phys. Rev. 71*, 209(1947)), and Brode (*Phys. Rev. 76*, 468(1949)) and may be explained in terms of multiple meson production with the existence of two sources distributed in the atmosphere, of which the first (formed by mesons created in the first collision by primary protons) is substantially responsible for the excess.

1694 On the production of mesons. H. Koppe. *Phys. Rev. 76*, 688(1949) Sept. 1 (Letter to the editor).

The relative yields of π mesons (produced by bombarding carbon atoms by protons) as a function of proton energy, which have been obtained by Jones and White (*Bull. Am. Phys. Soc. 24*, 8(1949)), are compared with the previous calculations for the yield of mesons produced by the interaction of light nuclei. The results obtained are in good agreement with the calculated values.

1695 On the spin of μ-mesons. J. Tiomno. *Phys. Rev. 76*, 856(1949) Sept. 15 (Letter to the editor).

It is shown that a zero spin for the μ-meson with a special type of coupling with electron, neutrino, and nucleons is in good agreement with the experimental results. The processes of μ-decay and of μ-capture by a nucleus are considered. It is concluded that the possibility of spin zero for μ_o-mesons is in good agreement with the experimental results.

1696 On the theory of atmospheric showers. I. The mean squares of angular and space deviations. Gert Molière. *Z. Physik 125*, 250-68(1949) (in German).

Assuming that the cascade formation is due to an accumulation of small-angle elementary scatterings, analogous to the multiple scattering of Williams (*Proc. Roy. Soc. (London) A 169*,

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531(1939)), a calculation is made of the mean squares of the angular and space deviations in the distribution of shower particles. Among the results is the important finding that the shower extension is three times greater than that derived in previous theories (Euler and Wergeland, *Astrophys. Norwegica 3*, 165(1940)). In the second part of this work, to appear later, the distribution functions of the scattering will be given, with the proof of the inadequacy of the assumption of a Gauss distribution of equal-energy electrons in a shower. The investigation is based on the author's general theory of scattering of charged particles (*Z. Naturforsch. 2a*, 133(1947); *3a*, 78(1948)).

1697 "Peculiar" showers of cosmic radiation. S. Azimov, et al. *Doklady Akad. Nauk. S.S.S.R. 65*, No. 5, 625-8(1949) Apr. (in Russian).

Showers of cosmic ray particles under a 13-cm lead plate discovered by the Pamir expedition in 1945 differ from ordinary atmospheric showers and have been termed "peculiar." Research on the nature of these showers continued in further Pamir expeditions in 1946 and 1947. Their main characteristic is the appearence of heavy, strongly ionizing and penetrating particles simultaneously with the appearance of electrons. The article describes several examples of the "peculiar" showers and shows their relation to atmospheric showers. Photographs are included in the article.

1698 Pulses produced in two ionization chambers by extensive atmospheric showers at 3,860 m altitude. L. A. Razorenov and A. K. Knyazev. *Zhur. Eksptl. i Teoret. Fiz. 19*, 283-91(1949) Apr. (in Russian).

A similar article by the authors was published in *Doklady Akad. Nauk. S.S.S.R. 60*, 1531-4 (1948) June 21. It was listed in *Nuclear Science Abstracts* as abstract No. 2-1199.

1699 Research on slow mesons by means of the method of retarding coincidences. G. B. Zhdanov and A. A. Naumov. *Zhur. Eksptl. i Teoret. Fiz. 19*, No. 4, 273-82(1949) Apr. (in Russian).

The article presents a description of a counter based on a variation of a radio circuit, which permits the recording coincidences by retarding them. It also explains the methods of calibration and control of the equipment. Some results of the investigations carried out by this method are given, including the whole number of slow mesons at an altitude of 5 km, the number of mesons being generated at 4 km, and the general character of the spectrum of the energy interval from zero to 160 Mev.

1700 Varitrons of various masses as observed on photographic plates. A. I. Alikhanyan, D. M. Samoĭlovich, I. I. Gurevich, Kh. P. Babayan, and R. I. Gerasimova. *Zhur. Eksptl. i Teoret. Fiz. 19*, 664-6(1949) July (in Russian).

Tracks of cosmic rays in photographic emulsions showed different grain densities depending, in every case, on the mass of the particle originating the track. By assuming that the grain density, (the number of developed grains in a unit length of a track ending in the emulsion), depends solely on the particle's velocity, we have $N(R)/R = F(R/M)$, where N is the total number of grains in a track of length R, and M is the mass of the particle. Using this for the various curves R -- N, relative masses were obtained, from which, with the aid of the proton curve, the following absolute masses were derived: 180-200, 320-350, 650-700, 950-1,000 (protons), 3,500-4,000, and 8,000-10,000 m_e. These results agree with those obtained by Alikhanian, et al (*Doklady Akad. Nauk. S.S.S.R. 58*, 1321(1947); *Zhur. Eksptl. i Teoret. Fiz. 18*, 673(1948)). The existence of particles of various masses (varitrons) in the cosmic rays was discovered by Alikhanian, et al (*J. Physics U.S.S.R. 11*, 97(1947)). Lattes, Occhialini, and Powell (*Nature 160*, 453 (1947)) found tracks of particles with masses 200 and 300 m_e only.

1701 Laboratory scale plastic pump for handling corrosive liquids. A. L. Allen, C. Craven, E. L. Fritts, and E. W. Powell. AECU-440 (K-481), Aug. 19, 1949. 9p.

A laboratory scale "Squeegee" pump fabricated from several plastic materials has been constructed to pump corrosive solutions such as hydrofluoric, nitric, sulfuric, and hydrochloric acids. The plastic construction prevents the corrosive fluids from coming in contact with any metal surfaces which might introduce metallic contamination. A rotating cam is used to collapse a flexible tube at the point of contact and to push the fluid ahead as it rolls along the length of the tube. As the tube expands behind the cam, additional fluid is drawn into the tube and the cycle is repeated. At slow speeds this action produces a pulsating flow, but as the speed of cam rotation is increased a continuous flow is approached.

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1702 Changes produced in solid bodies under the action of electrons in an electron microscope. A. I. Echeistova and A. B. Shekhter. *Izvest. Akad. Nauk. S.S.S.R., Otdelenie Khim. Nauk.* 238-41(1949) May-June (in Russian).

Observations were made on the structural changes, such as growing of structural elements or closing of pores, produced by impinging electrons on solids used as objects in the electron microscope. The solids studied were of a finely porous structure, characteristic of adsorbents, catalysts, etc.

1703 On an analyzer of mobilities for gaseous ions. Paul Langevin. *J. phys. radium 10,* 177-88(1949) June (in French).

On the basis of theoretical calculations an apparatus is proposed which would give the mobility "spectrum" of gaseous ions and also permit the study of the nature of the ions and their formation and evolution. The method described consists of putting the ions involved in a radial field; the gas moves with a rotational motion as it is carried along by a thin metallic cylindrical sliding ring which turns between two cylindrical fixed armatures, the axis of the system being vertical. The ions are emitted through a vertical slit in the stationary inner cylinder; horizontal slits in the moving cylinder permit their passage. The ions are collected by an isolated electrode in the form of a vertical "tongue" carried by the external stationary armature. The trajectory of the ions carried away, both by the field and by the motion of the fluid, is calculated. The precision of the apparatus, which can exceed 1%, is discussed and the various sources of error are studied, considering the sliding cylinder as infinitely thin. Experimental work is in progress to apply the method of mobility analysis of gaseous ions proposed.

1704 Homogenous magnetic field of circular boundaries applied to the mass spectrograph. M. Spighel. *J. phys. radium 10,* 207-12(1949) June (in French).

Recent improvements in ion source techniques necessitate considerable changes and simplifications in mass spectrography. Previously the magnetic sectors used in the Bainbridge, Jordan, and Mattauch spectrographs had linear boundaries. The use of surfaces having a particular radius of curvature, makes possible a linearity in the mass scale and the cancellation of the coefficient of α^2 in the expansion of "d," α being the aperture of the beam and d the distance on the plate between two neighboring trajectories, one corresponding to the average trajectory. The simplification in the calculation and the independence of the different required properties relative to the various parameters, facilitates the study of the geometry of the mass spectrograph. There is a resulting improvement in the sensitivity which should prove useful in different mass spectrographic applications.

1705 Ion source for mass spectrography. R. F. K. Herzog and F. P. Viehböck. *Phys. Rev. 76,* 855-6(1949) Sept. 15 (Letter to the editor).

An improved ion source for mass spectrography which makes use of sputtering is described. Two electric fields are used to accelerate the ions of the primary canal ray discharge and to remove the positive ions of the trial substance for analysis in a mass spectrograph. The latter is necessary because the positive ions are strongly linked to the cathode by the electric field. The sputtering takes place in a high vacuum and the ions are all accelerated by the same voltage and, therefore, are given uniform energies. In addition, the electric field acts as an electron-optic lens, producing a nearly parallel beam of rays.

1706 Electromagnetic radiation produced by collisions of slow neutrons with protons. J. Shmushkevich. *Zhur. Eksptl. i Teoret. Fiz. 19,* 353-7(1949) Apr. (in Russian).

Bethe and Peierls (*Proc. Roy. Soc. (London) A. 148,* 146(1935) and *149,* 176(1935)) have shown that, owing to the relatively low binding energy of the deuteron, the effective cross section of the elastic scattering of neutrons by protons can be calculated without the accurate knowledge of the potential energy form of the interaction involved. The present author applied these ideas to the problem of the deceleration radiation generated at collisions between slow neutrons (less than 20 Mev) and protons. The total cross section is shown to grow logarithmically with the neutron energy, according to the formula

$$\sigma \approx 1.6 \times 10^{-29} \left(\log \frac{4\pi E}{h\omega} - \frac{4}{3}\right) \text{cm}^2;$$

here the neutron's energy E is, as said above, considerably greater than the binding energy of the deuteron, and the radiation is composed of quanta with frequencies exceeding $\omega << \frac{2\pi E}{h}$.

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1707 The energy distribution of fission fragments from Pu^{239}. D. C. Brunton and W. B. Thompson. *Phys. Rev. 76*, 848-9(1949) Sept. 15 (Letter to the editor).

The energy distribution of fission fragments from Pu^{239} has been measured as a continuation of the work on U^{235} and U^{233}, reported previously (*Phys. Rev. 75*, 990(1949)). The results, in particular the nature of the "gated" distributions, are similar to those obtained for other fissile materials. Corrected values of 94.6 and 65.2 Mev were obtained for the light and heavy fragments, respectively. The results obtained are compared with those of Deutsch and Ramsey (MDDC-945). A contour diagram is shown in which the contour lines represent the relative frequency of occurrence of the fission modes. The most probable total kinetic energy was found to be a maximum at a mass ratio of 1.2 in agreement with the range measurements of Katcoff, et al (*Phys. Rev. 74*, 631(1948)). A mass diagram derived from the energy measurements is shown and compared with the mass curve obtained from chemical identification of the decay chains (Steinberg, et al, MDDC-1632 (1947)). A discrepancy between the curves which indicates that neutron emission occurs predominantly from the heavy fragment is noted; this contradicts the results of de Benedetti, et al (*Phys. Rev. 72*, 189(1947)) on the angular correlation of fission neutrons.

1708 The neutrons from the disintegration of sodium by deuterons. C. E. Mandeville.. *Phys. Rev. 76*, 436-7(1949) Aug. 1. (Letter to the editor).

A thick target of metallic sodium was bombarded by 5.6 μ amp-hr of 1.4-Mev deuterons in a Van de Graaff generator, since the presence of neutron group structure in the reaction $Na^{23} + D \rightarrow Mg^{24} + n^1 + Q$ should provide information on the nuclear energy levels of Mg^{24}. The neutrons were detected by the production of recoil protons in Ilford C_2 photographic emulsions located 9 cm from the target and at 90° to the incident beam. A total of 1450 acceptable tracks were measured. The Q-values calculated from the observed neutron energy groups, as indicated by the energies of the proton recoils, indicate energy levels in Mg^{24} at 0.83, 1.24, 1.66, 4.16, 7.70, and 8.64 Mev. In addition the data obtained suggest that in the case of Na^{24} the 1.38-Mev γ-ray is the second of the two γ-rays emitted by that nucleus.

1709 On the decrease of neutron densities at boundaries. H. Raether. *Z. Physik 125*, 269-73 (1949) (in German).

Measurements are described of the drop in the density of thermal neutrons at the boundaries of a neutron-containing volume of water (H_2O,D_2O). The observed deviations from the theoretical density distribution are discussed and explained by taking into account the unsymmetrical angular distribution of thermal neutrons after their collisions with the hydrogen nuclei. The average value of the cosine of the scattering angle for the deuterium nucleus is found to be about 0.3.

1710 Relativistic scattering of neutrons by protons. D. Basu. *Proc. Roy. Irish Acad. 52 A*, No. 10, 127-41(1949) June.

The scattering of neutrons by protons is investigated theoretically in order to compare the theoretical and experimental angular distributions. Recent experiments by Powell and Occhialini (*Phys. Soc. Cambridge Conference Report*, 150(1947)) and by others indicate that the ratio of the differential cross section in the backward and perpendicular direction referred to the center of mass system is greater than one for neutrons of energy 13 Mev. Although this indicates that the interaction is predominantly an exchange type and due to charged mesons, the latter alone fail to account for the equality of the neutron-proton and proton-proton forces in corresponding states. Thus, it is necessary to choose a symmetrical theory in which both charged and neutral mesons maintain the equality of forces between like and unlike particles. The proton-neutron scattering is investigated by the author in the high energy region, where the Born approximation can be applied, and in particular in the relativistic region. Here the effect of retardation is accounted for by the mechanism of exchange of mesons. Since charged vector mesons alone fail to explain the facts, and, furthermore, the scattering due to the mesonic dipole (g_2-interaction) is much more pronounced at high energies than that due to g_1, the charge symmetrical combination of vector and pseudoscalar fields is used. In order to study the influence of the tensor-force with the $1/r^3$ singularity and of the contact potentials, results are given separately for the various types of fields. The results of the calculations show that the g_1 scattering if neutrons by protons, with the δ-function eliminated in the way described, decreases with increasing energy and tends to a constant in the relativistic region. The g_2 scattering, with the new modifications, also decreases with energy in the non-relativistic region if the Møller and Rosenfeld combination is used, but increases again in the relativistic region.

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This indefinite increase with energy is due to the re-appearance of high order singularities in the relativistic region and partly, perhaps, due to contact potentials not cancelling in the relativistic region. This increase constitutes a difficulty which may be remedied by using the theory of damping in place of the Born approximation; this will be investigated in a subsequent paper.

1711 Spontaneous neutron emission from uranium and samarium. Herman Yagoda and Nathan Kaplan. *Phys. Rev. 76*, 702-3(1949) Sept. 1 (Letter to the editor).

An exceedingly sensitive recording medium for the measurement of slow neutron flux has been used to obtain data on the spontaneous emission of neutrons by samarium and uranium. The calibration data for 200μ Ilford C2 plates into which about 15 mg of B^{10} and 2 mg of Li^6 had been incorporated (*Phys. Rev. 75*, 1328(1949)) suggested that by extending the exposure to 500 hr, flux of the order of 2×10^{-6} slow neutron/sec/cm^2 could be measured with an uncertainty of less than 20%. The data taken indicated: (1) an average cosmic ray slow neutron flux of 20.1 cm^{-2}/day, and, (2) the emission of about 13.3×10^3 fast neutrons/cc/day for the samarium. The emission of 2470-2660 fast neutrons/day/g of uranium was determined which indicated a reproducibility of about 5%.

1712 Investigation of nuclear energy levels in lead. H. H. Barschall, C. K. Bockelman, R. E. Peterson, and R. K. Adair. AECU-381, nd. 20p.

The total neutron cross section of Pb was measured from 20 kev to 750 kev with an energy spread of 10 kev. Maxima were observed at 350, 525, and 720 kev, each maximum being preceded by a minimum. In the region surrounding these anomalies measurements were carried out with a resolution of about 5 kev. An attempt was made to interpret the maxima as due to resonances corresponding to isolated levels in the compound nucleus Pb^{209}. No energy levels were resolved when similar measurements were carried out for Bi.

1713 Collection efficiency for bromine ions. E. J. Hellund. AECU-423, 1949. 5p.

The problem considered in this paper arose in an experiment in which a study was made of the charge and energy of γ-recoil Br nuclei. The Br was present as neutron irradiated ethyl bromide. The recoil of γ emission broke the chemical bond and freed the Br nucleus, which was then collected by means of an electrical field upon a rod or wire. The collecting chamber consisted of two concentric cylinders with a potential difference such that collection was possible due to subsequent β emission. The efficiency of collection as a function of the charge, mass, and energy of the Br nuclei, the radii of the outer and inner cylinders, and potential difference between the cylinders is discussed. No consideration of end effects is attempted due to the fact that the ratio of the length of the tube to the diameter of the outer cylinder was about 30 to 1. A mathematical analysis starting with an expression for the radial velocity of the ion based on conservation of energy and angular momentum is developed. Application of the theory shows less than 100% efficiency.

1714 On closed shells in nuclei. II. Maria G. Mayer. AECU-424, Apr. 1949. 6p.

The use of spins and magnetic moments of even-odd nuclei to determine the angular momentum of the eigenfunction of the odd particle, and the prevalence of isomerism in certain regions of the isotope chart are discussed and explained. Tabulated data are given on levels of square well potential, spectroscopic levels, spin terms, number of states, and shells. Also tabulated are the known spins and orbital assignments from magnetic moment for the even-odd nuclei up to 83 (bismuth).

1715 Energy levels in N^{15} and N^{16}. L. D. Wyly. *Phys. Rev. 76*, 316-17(1949) July 15 (Letter to the editor).

A check of the new higher excitation levels in the N^{15} nucleus reported by Guggenheimer, et al (*Proc. Roy. Soc. 190*, 196(1947)) has been made using the counters described by Martin (*Phys. Rev. 72*, 378(1947)) for proton detection. A normal ammonia target and one enriched 61.5% in N^{15} were bombarded with 3.32-Mev deuterons. The yield curves are shown and Q-values for the $N^{14}(d,p)N^{15}$ reaction are compared with the previous values. It is noted that the 6-Mev level is confirmed as well as the fact that the 7.2-Mev level is double. An average ground state Q-value of 0.23 ± 0.15 Mev was obtained for the $N^{15}(d,p)N^{16}$ reaction; from this a mass value of 16.01121 ± 0.00023 mass units was obtained for N^{16}.

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1716 Energy levels of Si^{30}. John E. Brolley, Jr., M. B. Sampson, and Allan C. G. Mitchell. *Phys. Rev. 76*, 624-7(1949) Sept. 1.

The distribution in range of the protons arising when aluminum is bombarded by 22-Mev α particles, produced in the cyclotron, has been investigated. Seven groups of protons, having energies up to 17 Mev, have been measured. The energy levels of the resulting Si^{30} nucleus have been calculated and are found to be 0.0, (2.28), 3.49, 7.18, 8.20, 9.26, 9.87, and 10.86 Mev. The inelastic scattering of protons from aluminum has also been measured. (The value in parentheses has been previously reported by other investigators).

1717 Hyperfine structure of Fe 57. Jean Brossel. *Phys. Rev. 76*, 858-9(1949) Sept. 15 (Letter to the editor).

A search for the hyperfine structure of Fe^{57} was carried out by means of a Fabry-Perot interferometer, crossed with a 35-ft concave grating in the Wadsworth stigmatic mounting. No structure, broadening, or asymmetry was found in the region between 2400A and 6000A. The lines observed are tabulated. It is noted that the results are in agreement with those reported recently (M. Gurevitch and J. G. Teasdale, *Phys. Rev. 76*, 151(1949)) and similar to those concerning Ni^{61}.

1718 A lower limit for the binding energy of the deuteron. G. R. Bishop, C. H. Collie, H. Halban, and R. Wilson. *Phys. Rev. 76*, 683-4(1949) Sept. 1 (Letter to the editor).

An investigation has been made by comparing the photo-disintegration produced in deuterium by the γ rays from radio-gallium and radio-thorium to determine whether the 2.21-Mev γ ray from Ga^{72} can produce photo-neuterons from deuterium; if it does, then $-Q_\gamma$ the binding energy of the deuteron, must lie below 2.21 Mev. Tabulated data are given for the ratios: RdTh neutrons/Ga neutrons, RdTh protons/Ga protons, and photo-proton ratio/photo-neutron ratio. The photo-protons were detected by means of an ionization chamber filled with deuterium gas, while the photo-neutron measurements were made using a sphere of heavy water by means of the method of integrating the slow neutron density in a water tank using manganese as a detector. The results obtained are interpreted as indicating that the binding energy of the deuteron cannot be less than 2.207 Mev.

1719 The magnetic moments of Sn^{117}, Sn^{119}, and Pb^{207}. W. G. Proctor. *Phys. Rev. 76*, 684(1949) Sept. 1 (Letter to the editor).

Using the nuclear induction spectrometer described in a previous letter (*Phys. Rev. 75*, 522 (1949)), the magnetic moments of the nuclei Sn^{117}, Sn^{119}, and Pb^{207} have been remeasured. The results are in good agreement with those from hyperfine structure measurements through which they were previously known, and which indicated for both tin nuclei a spin of 1/2 and a magnetic moment of -0.89 nuclear magneton, and for the nucleus Pb^{207} a spin of 1/2 and a magnetic moment of +0.6 nuclear magneton. The exact values obtained were:
$\mu(Sn^{117}) = -(1.000 \pm 0.001)\,\mu_N$, $\mu(Sn^{119}) = -(1.047 \pm 0.0001)\,\mu_N$, $\mu(Pb^{207}) = +(0.588 \pm 0.001)\mu_N$.

1720 Nuclear gyromagnetic ratios. II. William H. Chambers and Dudley Williams. *Phys. Rev. 76*, 638-40(1949) Sept. 1.

By means of super-regenerative oscillator techniques, magnetic resonance absorption peaks have been observed for Be^9, P^{31}, Cl^{35}, Rb^{85}, Cs^{133}, and La^{139}. By simultaneous observation of each of these resonances and of the proton absorption peak in the same magnetic field, the ratio of the resonance frequency ν of each of these nuclei to the proton frequency ν_p in the same applied field has been determined. The experimental results are as follows:

Nucleus	ν/ν_p
Be^9	0.14034±0.00007
P^{31}	0.40490±0.00011
Cl^{35}	0.09799±0.00007
Rb^{85}	0.09661±0.00004
Cs^{133}	0.13093±0.00014
La^{139}	0.14116±0.00014

From these experimental results, the gyromagnetic ratio for each nucleus can be determined in terms of the gyromagnetic ratio of the proton provided suitable corrections for the diamagnetism of the electrons are applied.

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1721 Nuclear spin and magnetic moment of Cs^{135} and Cs^{137}. Darragh E. Nagle. *Phys. Rev. 76*, 847-8(1949) Sept. 15 (Letter to the editor).

An atomic beam magnetic resonance apparatus with a mass spectrometric detector, similar to that used by Davis (*Phys. Rev. 76*, 435(1949)), has been used to measure the nuclear spins and magnetic moments of Cs^{135} and Cs^{137}. The apparatus was arranged to detect those atoms in the beam which: (1) belong to the alkali family, (2) are of specified mass number, and (3) undergo a change in state in the transition field which corresponds to a change of ±1 in the quantum number m_j for strong magnetic fields. Tabulated data and curves are shown; from these the spin of both nuclei has been determined as 7/2 and the nuclear magnetic moments have been determined as 2.721 ± 0.01 and 2.833 ± 0.01 nuclear magnetons, respectively, for Cs^{135} and Cs^{137}. The value obtained for the latter is in agreement with the results previously obtained by Davis.

1722 The system of stable nuclei. A. H. W. Aten, Jr. *Science 110*, 260-1(1949) Sept. 9 (Comment and communication).

The conclusion recently reached by Way (*Phys. Rev. 75*, 1448(1949)), that in the neighborhood of Z = 82 and of N = 126, nuclei with a number of protons or neutrons only approximately equal to these numbers have abnormally high binding energies, has been reached independently by Wapstra in the Netherlands (Rosenfeld, Nuclear Forces I, New York, Interscience, 1948, pp. 525-529). As an illustrative example, the binding energies of a series of isotopes of a single element with neutron numbers between 120 and 132 are discussed qualitatively. The stable odd mass nuclei are considered and the suggestions of various investigators reviewed. A similar treatment is accorded the stable nuclei of even mass. Some of the gaps in the periodic system which are difficult to explain and some of the anomalous abundances are discussed in the light of stability considerations.

1723 Instrumentation for an atomic power plant. D. Cochran and C. A. Hansen, Jr. AECD-2656, nd. Decl. Apr. 28, 1949. 16p.

Some of the unusual problems of applying instruments in an atomic power plant are discussed. These problems arise from the presence of intense radiation and high temperature in much of the system. Operation of the plant requires much elaborate instrumentation, most of which is made up of standard commercial devices; however, many unusual requirements must be met by specially designed instruments. These can be classified according to their general function as follows: (1) operation - instruments required for the control and safety of the plant operation; (2) maintenance - instruments to observe the condition and behavior of the reactor structure, fuel elements, coolant, and blanketing gas as the operation of the plant proceeds; (3) health - instruments required to monitor radiation leakage in the plant to insure protection of operating personnel. General design requirements and the development of adequate instruments for the various specific applications are discussed.

1724 How an atomic pile functions. Pierre Rousseau. *La Nature*, No. 3167, 65-9(1949) Mar. (in French).

A brief review of fission, chain reaction, and the design and operation of an atomic pile is followed by the author's concept of an atomic power plant. Photographic and diagrammatic illustrations are included.

1725 The production of fast deuterons in high energy nuclear reactions. G. F. Chew and M. L. Goldberger. AECU-385, (UCRL-364) July 11, 1949. 24p.

It is proposed that the fast deuterons observed among the products of high energy nuclear reactions are to be understood in terms of a "pickup" or sudden rearrangement process. A theoretical treatment of such a process is given which suffices to interpret presently existing data. Further experiments are proposed to test the hypothesis critically, and a possible application of this type of experiment to the determination of nuclear wave functions is pointed out. It is pointed out that the pickup process must not be thought of as taking place within the nucleus, following a real collision of the neutron and proton. The period of the deuteron is considerably longer than the time required for a 100-Mev neutron or proton to cross the nucleus, and the "radius" of the deuteron is as large as the mean separation of the constituents of a heavier nucleus. The "scattering" is virtual and does not obey the energy-momentum requirements of a free neutron-proton collision. The part of the wave function corresponding to the outgoing deuteron does not materialize as such until long after the nuclear event. 11 references.

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1726 High energy induced fission of bismuth and lead. R. H. Goeckermann and I. Perlman. *Phys. Rev. 76*, 628-37(1949) Sept. 1. (See also NSA 2-1613).

A study has been made of the characteristics of the fission induced in bismuth and lead by irradiation with high energy deuterons (190 Mev) using radiochemical methods for the determination of yields of the fission products. The fission yield curve resulting from 190-Mev deuteron fission of bismuth was found to be a single symmetrical peak with a maximum fission yield of 5.0% at a mass number of approximately 100. The ratio of neutrons to protons was observed to be nearly constant for all nuclides formed in relatively good yield. The excitation function of the Mo^{99} yield in two lead samples enriched, respectively, in Pb^{204} and Pb^{208} showed that the fission cross section is larger and decreases less rapidly as the deuteron energy decreases in the lead sample which has a higher proportion of the light isotopes. A mechanism has been postulated for the nuclear reaction which involves prior neutron evaporation from the initial highly excited nucleus followed by fission with unchanged charge distribution.

1727 Operation of the 1/4 scale model bevatron. II. E. J. Lofgren. AECU-435(UCRL-398), July 13, 1949. 16p. (See also NSA 3-1278).

This report is an outline of what has been learned on the 1/4 Scale Bevatron during June. Substantial progress has been made in the study of pressure effects on the beam, beam injection, and tank aperture. There has also been improvement in the maximum beam and in the stability of some of the control circuits. On some important problems such as frequency tracking, no improvement has yet been made.

1728 Operation of the 1/4 scale model bevatron. III. E. J. Lofgren. AECU-450(UCRL-412), Aug. 1, 1949. 11p. (See also NSA 3-1278).

During the period July 1-August 1 the greatest attention has been given to improving operating stability. A marked improvement has been made so that it is now possible to work more easily on the remaining important problem, which is extension of the beam acceleration to long acceleration times.

1729 Double refraction of flow and the dimensions of large asymmetrical molecules. Harold A. Scheraga, John T. Edsall, and J. Orten Gadd, Jr. AECU-462(HUX-4), Sept. 1949. 35p.

The method of optical measurements of double refraction of flow in systems containing large asymmetrical molecules gives experimental data which, when interpreted in light of the theory of Peterlin and Stuart (Hand. u. Jahrb. d. Chem. Physik, *Bd. 8, Abt. IB* (1943); *Z. Physik*, III, 232(1938); *Z. Physik*, 112, 1, 129(1939)), enable one to calculate molecular lengths; information about the polydispersity of the system and about the optical properties of the solute particles may also be obtained from such data. Heretofore, this theory had been developed so that the data could be interpreted only under the limiting condition of low velocity gradient where the degree of orientation of the solute particles is very small. With the aid of the Mark I computer, the necessary equations have been solved to provide numerical values over a much wider range of velocity gradients, greatly increasing the usefulness of flow birefringence measurements for the study of macromolecular systems. 26 references.

1730 Electron emission produced by bombarding dielectric membranes with positive ions. S. V. Starodubtsev. *Zhur. Eksptl. i Teoret. Fiz. 19*, 297-9(1949) Apr. (in Russian) (See also NSA 2-1820).

Emission of electrons from thin layers of dielectrics that have been subjected to a preliminary bombardment with positive ions was discovered by Malter (*Phys. Rev. 49*, 378(1936) and *50*, 48(1936)). The present author studied this effect on membranes of B_2O_3 and KCl, about 2×10^{-4} cm thick, bombarded by potassium ions. A steady electron emission was observed, lasting long after the bombardment had ceased. The phenomenon is explained by a continuous positive recharging of the membrane due to the ionization produced by the electrons during their passage through the membrane. 18 references, half of which are Russian.

1731 Foundations of nuclear physics. Forward by R. T. Beyer. New York, Dover Publications, Inc. 1949. 272p.

Thirteen fundamental studies, previously published in scientific journals, have been collected as the most significant articles for tracing the development of nuclear physics. Included are the original articles on the discoveries of the various elementary particles and of the fission process as well as several of the major original theoretical papers of nuclear physics. An extensive subject bibliography (117p) is included in addition to a list of the periodicals which currently publish material on nuclear physics.

PHYSICS (continued)

1732 Introduction to atomic physics. Otto Oldenberg. New York, McGraw-Hill, 1949. 373p.
This book grew out of a course which the author has been giving at Harvard University since 1931. Calculus is not necessary for the understanding of atomic physics on the introductory level. Therefore, in this book the relation between theory and observed facts is stressed throughout. The main emphasis is on understanding as opposed to accepting an authority.

1733 Magnitudes and energy units in atomic physics. U. Stille. *Z. Physik. 125*, 174-209 (1948) Oct. (in German).
In the first part of this work the problem of the atom constants is submitted to a general analysis. Special attention is given to the following magnitudes: the specific molecule number N_L, in the light of Straumanis' (*Z. anal. Chem. 120*, 168(1940)) work on the admixtures in calcite crystals used for the determinations of lattice constants; the specific ion charge F, with a special reference to a discussion of this constant by Birge (*Repts Progress Phys. 8*, 90(1942)); the h/e ratio, in the light of recent investigations of Ohlin (*Arkiv Mat., Astron. Fysik A 31*, No. 9 (1944)) and Dumond, et al (*Phys. Rev. 59*, 219(1941)). All the other auxiliary magnitudes, atomic constants and fundamental spectroscopic constants are given, as determined by recent measurements; the list includes the universal gas constant R_o and the Boltzmann entropy constant k. In the second part of the paper the most important magnitudes and constants of atomic and nuclear physics are presented in a coherent system of values that are derived from the following basic magnitudes: the light velocity in vacuum c_o, the induction constants μ_o, the universal gas constant R_o, the specific molecule number N_L, the specific ion charge F, the specific electron charge e/m_o, the Rydberg constant and the atomic masses of the isotopes of light elements. In the third part the problem is discussed of the numerical relationship between the energy units used in atomic and nuclear physics, such as ev, sec^{-1}, m^{-1}, 1°K, and 0.001 of the rest energy of a hypothetical particle with mass = 1, as well as the mechanical and electrical energy units.

1734 Structure of the atoms and atomic energy. Paris, Hermann, 1948. 144p. (in French).
This is a series of eight lectures delivered at the French Conservatoire des Arts-et-Metiers by various specialists on current questions related to nuclear physics.

1735 A 22-inch Wilson cloud chamber in a magnetic field of 21,700 gauss. Wilson M. Powell. AECU-431 (UCRL-297), Mar. 7, 1949. 27p.
A Wilson cloud chamber 22 in. in diameter in a magnet producing a magnetic field of 21,700 gauss at the center of the chamber is described. The magnet is pulsed in synchronism with the 184-in. Berkeley cyclotron and can be operated with a steady field of 10,000 gauss. This cloud chamber and magnet may be used not only to make accurate curvature measurements on the tracks of fast particles but also to identify the slow particles that result from the disintegrations of nuclei. Protons, alpha particles, and deuterons can be distinguished with little ambiguity near the end of their range.

1736 On the construction of metallic Geiger-Müller counters. M. Lesage, A. Rogozinski, and A. Voisin. *J. phys. radium 10*, 212-13(1949) June (in French).
Details are given of the preparation and the construction of metallic counters in which the assembly is made exclusively by the use of tin solders, brazing, and a glass-metal seal for the insulated outlet.

1737 Radioactive measurements with nuclear emulsions. Herman Yagoda. New York, John Wiley and Sons. 1949. 356p.
The photographic and scintillation methods of detecting nuclear particles and radiations are compared. Problems peculiar to the various types of detectors necessary for detection of α-particles, β-particles, γ-radiation, mesons and other cosmic ray components, and fission fragments by means of emulsions, are considered. The techniques of β autoradiography are described. Some of the applications of nuclear emulsions in metallography and crystallography are also discussed. 18p bibliography.

1738 Report on high pressure gasket test. J. A. Vitale. MIT Laboratory for Nuclear Science and Engineering Technical Report No. 1. Feb. 1, 1947. 7p. (NP-1039)
A gasketry arrangement suitable for high pressure work was developed and tested as applied to a high pressure cloud chamber. A satisfactory gasket scheme for this application must be as nearly leakproof as possible at 3000 psi even when the initial or tightening pressure is relaxed

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due to deflection, be easily assembled and disassembled, not require too close machining tolerances, and not be very position sensitive. With these requirements in mind, a gasket arrangement was developed, tested and found satisfactory. The pump used was a standard hydraulic jack of 5 ton capacity.

1739 Cerenkov radiation from protons. Robert L. Mather. AECU-451(UCRL-409), Aug. 4, 1949. 6p.

Cerenkov radiation (*Doklady Akad. Nauk. S.S.S.R. 8*, 451(1934)) is essentially an electromagnetic shock wave excited by the passage of a charged particle through a medium with a greater velocity than the velocity of electromagnetic radiation in that medium. This is analogous to the shock wave observed from a high velocity projectile in air. Proof of the existence of Cerenkov radiation consists of showing the unique angular distribution of the light, as all other usual sources of light production would give a broader angular distribution and a different dependence of the angle on the particle velocity. Cerenkov radiation has been observed for the first time from 345-Mev protons in the deflected beam of the 184-in. cyclotron. Two types of medium were used: extra dense flint glass and amorphous silver chloride. The directional character of the radiation was verified as well as its dependence on proton energy. Calculation of the energy of the protons from the experimental results agreed with range experiments within the limits of experimental error.

1740 The cross section of atoms for the non-elastic scattering of fast electrons. Heinz Koppe. *Z. Physik 124*, 658-64(1948) Sept. (in German).

The scattering of electrons by atoms has been frequently studied. However, the applications of this phenomenon in the electron microscope demand that a single formula should be derived, valid for all atoms and giving the total cross section for electron scattering. Debye (*Physik. Z. 31*, 413(1930)), using the Thomas-Fermi universal density distribution, gave a formula for the elastic scattering, from which, through integration over the scattering angle, the required total cross section can be obtained. Heisenberg (*Physik. Z. 32*, 739(1931)) extended Debye's method to the non-elastic scattering. The present author attempted, through integration, the calculation of the corresponding total cross section. He found it impossible because of the divergence of the integral when the angle approaches zero. Appropriate procedures remove this difficulty.

1741 Branching ratio in Be^7 decay. C. M. Turner. AECU-432(UCRL-319), July 20, 1949. 20p. (See also NSA 2-2196).

In this revision and amplification of AECU-211, experimental procedures and final results are given in more detail. The value found for the branching ratio after applying a correction for counter calibration is 0. 118±10%. 21 references.

1742 The beta-ray spectrum of chlorine^{36}. C. S. Wu and L. Feldman. AECU-443(CUD-27), July 1, 1949. 9p.

The β spectrum of Cl^{36} has been investigated in the Columbia solenoid magnetic β spectrometer and found to exhibit a highly forbidden shape. Its Fermi plot could be fitted satisfactorily with a D_2 spectrum, which is the unique spectrum predicted theoretically for Be^{10} where the change of spin involved is ±3 units. However, the authors state that recent measurement of the spin change of Cl^{36} has given a value of 2, which invalidates the preceding conclusions. The theoretical interpretation of Cl^{36} spectrum with spin change 2-0 is presented in AECU-446.

1743 Beta spectrum of Y^{91}. C. S. Wu and L. Feldman. AECU-444(CUD-28), July 1, 1949. 7p.

The β spectrum of Y^{91} has been investigated in a β spectrometer under almost identical conditions as that for Cl^{36} (see AECU-443). The Fermi plot of Y^{91} fits the $\alpha \sim (p^2 + q^2)^{1/2}$ spectrum satisfactorily.

1744 Radioactivity of chlorine^{36}. C. S. Wu, C. H. Townes, and L. Feldman. AECU-445 (CUD-29), July 1, 1949. 10p.

The half-life of Cl^{36} has been estimated by the method of determining the specific disintegration rate to be $(0.44 \pm .05) \times 10^6$ yr. A search of positrons in the β spectrometer confirmed the recently published ratio of positrons to negatrons as less than 10^{-4}. No gamma rays are associated with the disintegration of Cl^{36} unless they are of very low energy or of low intensity.

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1745 On the spin and beta-spectrum of Cl^{36}. C. Longmire, C. S. Wu, and C. H. Townes. AECU-446(CUD-30), July 5, 1949. 7p.

The theoretical interpretation of Cl^{36} forbidden spectrum with spin change 2-0 is presented in this letter. It is found that the spectrum cannot be explained by any single type of interaction. However, the spectrum can be fitted satisfactorily by three of the combinations of interactions; namely (S,T), (V,T), (V,A) but not by the combination of (S,A). Moreover, these combinations of interactions give agreement with the observed spectra for Y^{91}, Y^{90}, Sr^{90}, Sr^{89}, and Cs^{137}.

1746 Interpretation of beta-spectra from thick sources. L. Feldman and C. S. Wu. AECU-447 (CUD-31), July 5, 1949. 9p.

The distortion of thick sources on the β spectra of Y^{91}, P^{32}, and Bi^{210} has been studied. These were chosen because the shape of their Fermi plots are radically different: convex for Bi^{210}, straight for P^{32}, and concave over most of the spectrum for Y^{91}. The results are summarized by stating that sources of the thickness investigated will increase the second derivative of the Fermi plot in the direction from concave to straight line to convex to greater convexity. Reexamination of the results of Alburger (*Phys. Rev. 75*, 1442(1949)) has led to the conclusion that the true Fermi plot of K^{40} β spectrum is probably not straight but concave towards the energy axis.

1747 The beta-spectrum of Be^{10}. C. S. Wu and L. Feldman. AECU-448(CUD-32), July 5, 1949. 9p.

The β spectrum of Be^{10} has special theroretical interests because the spin change involved in this transition is 3 units and its forbidden shape predicted theoretically should be an unique D_2 spectrum. From a comparative study of the spectra of Cl^{36} (713 kev), Be^{10} (550 kev), and Cu^{64} (e^- 571 kev; e^+ 657 kev) in thick BeO sources, it is concluded that the true distribution of the Be^{10} β spectrum cannot be of allowed type. It is probably more concave than an α spectrum and may well be a D_2 spectrum.

1748 The beta-spectrum of O^{15}. V. Perez-Mendez and H. Brown. AECU-449(CUD-33), July 6, 1949. 8p.

A magnetic semicircular-focusing β-ray spectrometer was used, together with a source consisting of a gas in a container, to obtain the β^+ spectrum of O^{15}. The O^{15} was produced by the $N^{14}(d,n)O^{15}$ reaction, by use of a gas probe. The spectrum has an extrapolated end-point of 1.683±0.005 Mev, and is of the shape predicted by the theory of allowed spectra.

1749 Chemistry and radiochemistry of phosphorus-bakelite beta ray sources. W. T. Burnett, Jr., P. C. Tompkins, and Leon Wish. AECU-455(ORNL-263), Sept. 6, 1949. 83p.

A study is presented of the physical, chemical, and radiochemical properties of the phosphorus-impregnated bakelite plaques developed previously by Raper et al (MDDC-661), as sources of beta radiation. A summary of the most pertinent information is tabulated and suggested specifications and control tests for plaque material are given. A procedure for dissolving phosphorus-impregnated bakelite, procedures for radioautographs, preparation of a sample for spectrographic analysis, technique and apparatus for powdering activated material, design of activation box, techniques and apparatus for breaking up an activated plaque, technique and apparatus used in weighing active pieces of placque, dry box manipulations for transfers and measurements, vacuum type transfer tongs for open transfers, and shipping and storage containers, are described in appendices. The calculation of radiation intensity from specific activity is shown. 17 references.

1750 Beta emitting isotopes of tin. A. S. Newton and W. R. McDonell. AECU-457(UCRL-395), July 11, 1949. 23p.

The β^- emitting isotopes of Sn have been investigated using deuteron bombardments of Sn isotopes enriched in Sn^{120}, Sn^{122}, and Sn^{124}, respectively. The "40-min" period has been shown to consist of 2 periods: a 41-min Sn^{121} with a β^- energy of about 2.5 Mev accompanied by a γ ray of about 0.27 Mev, and a 39-min period assigned to Sn^{123} with a β^- energy of about 1.7 Mev accompanied by a γ ray of about 0.17 Mev and Sb x-rays. The 9.5-day period has been shown to emit a β^- of energy 2.38 Mev, no Sb or Sn x-rays, and probably no γ rays. The 130-day period has been assigned to mass 123. The assignment of these and other Sn periods is discussed, and the status of the β-emitting Sn isotopes summarized.

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1751 Alpha-decay in isotopes of atomic number less than 83. S. G. Tompson, A. Ghiorso, J. O. Rasmussen, and G. T. Seaborg. AECU-459(UCRL-437), Sept. 5, 1949. 5p.

Thin targets of gold leaf have been bombarded with 190-Mev deuterons in the 184-inch cyclotron. Two α-decay periods were observed in these targets; one of 0.7 min half-life and another of 4.3 min half-life. The α-particle energies were 5.7 and 5.2 Mev, respectively. Chemical separations proved that the 4.3-min period is due to an Au isotope and suggested that the 0.7-min period is due to a Hg isotope. The mass numbers of these new isotopes have not been determined. However, the results of excitation-functions in the production of the Au isotope by bombarding Au and Pt with protons suggest that its mass number lies in the range 185 to 188. The work on this isotope indicates that the α to electron capture branching ratio is of the order of magnitude of 10^{-4}, and that positron activity accompanies the 4.3-min α-period. Very recently Sm_2O_3, Gd_2O_3, and Dy_2O_3 targets were bombarded similarly with 200-Mev protons. Several new α-decay periods were observed in the Gd and Dy targets, but significant α-activity was absent in the Sm target. In the Gd bombardment there was present an α-decay period of approximately 7 min half-life and another of about 4 hr half-life, the α-particle energies being approximately 4.2 and 4.0 Mev, respectively, as determined with a pulse analyzer apparatus. In the Dy bombardment, three α-decay periods were observed, namely $\sim$ 7 min, $\sim$ 20 min, and $\sim$ 4 hr with α-particle energies of 4.2, 4.1, and 4.0 Mev, respectively. Present also were some electromagnetic radiation and a smaller amount of positron activity. From results with a Geiger counter, it appears that a minimum value for the ratio of α to electron capture is approximately 1% for the 4-hr activity. A brief interpretation of the rather limited data is given.

1752 New low mass isotopes of emanation (element 86). A. Ghiorso, W. W. Meinke, and G. T. Seaborg. AECU-460(UCRL-438), Sept. 5, 1949. 4p.

This is not an abstract; the document is reproduced below in its entirety.

Among the spallation products obtained from the 350-Mev proton bombardment of Th^{232} we have identified two gaseous alpha emitters which apparently do not decay into any presently known alpha-decay chains. The half-lives observed for the decay of the alpha activities are 23 min and 2.1 hr. These half-lives may be principally determined by an unknown amount of orbital electron capture. At least one alpha-emitting daughter (about 4 hr half-life) has been observed to grow from a gaseous parent, but it has not been determined whether it arises from alpha decay or electron capture.

Since these gaseous atoms emit alpha particles it is assumed that they are isotopes of element 86 (emanation of radon) rather than a lighter rare gas. If they were heavy isotopes such as Em^{221} or Em^{223}, both unknown, they would decay into known alpha-decay series, the neptunium and actinium series, respectively, and so would grow known short lived alpha emitters which would have been detected. It thus appears reasonable that they must be lighter than the known emanation isotopes.

The lightest isotope of emanation observed prior to these experiments was Em^{216}, which arises from the U^{228} alpha-decay series (W. W. Meinke et al, *Phys. Rev. 75*, 314(1949)) and which should have a half-life of approximately 10 μsec as predicted by means of the new alpha-decay systematics (I. Perlman, et al, *Phys. Rev. 74*, 1730(1948); *75*, 1096(1949)). The reappearance of longer half-lives, such as 23 min and 2.1 hr, with lower mass numbers is apparently due to the stable configuration of 126 neutrons. Thus these activities are to be assigned to the mass numbers 212 and lower (that is, Em^{212} and $Em^{<212}$). Therefore, it appears that the plot of alpha energy versus mass number for the isotopes of emanation goes through the same type of maximum and minimum as is observed for bismuth, polonium and astatine. (I. Perlman, et al, *Phys. Rev. 74*, 1730(1948)).

The method used to measure the emanation alpha activities was very simple but designed to separate the emanation from tremendous amount of other alpha emitters, from bismuth to protactinium. The cyclotron target consisted of thin thorium metal strips sandwiched with thin aluminium foils to act as catchers for the transmuted atoms which were able to recoil out of the surface of the thorium. These aluminum foils were then heated at a very low temperature of a vacuum system. A slow stream of argon "carried" the emanation through two cold traps at -50°C and into a final trap at -90°C where the emanation should freeze out. From this storage trap it was possible to fill a cylindrical ion chamber in which alpha pulses could be detected. In order to prove that a gas was involved it was shown that the activity could be quantitatively transferred back and forth many times by varying the temperature of the cold trap. After an emanation sample had been allowed to decay for some hours the gas was thoroughly pumped out of the

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chamber and the alpha activity left behind (presumably due to the daughters) was followed for decay. It was not possible to measure alpha energies in these first experiments and Geiger counter measurements were clouded by the probability of xenon and krypton fission product contaminants from which no careful separation had been made.

New equipment is now being built with which it should be possible to measure alpha energies for these emanation isotopes and their daughters and to determine the proper mass assignments.

1753 Beta spectrum of Au^{198}. L. Ya. Shavtvalov. *Zhur. Eskptl. i Teoret. Fiz. 19*, 633-6 (1949) July (in Russian).

With the aid of a magnetic spectrometer a determination was made of the beta spectrum of Au^{198}. The spectrum is of the simple type with an upper limit equal to 970 kev. The coefficient of internal conversion for the γ line of 415 kev energy is equal to 0.007.

1754 Beta-spectra of forbidden transitions. Lawrence M. Langer and H. Clay Price, Jr. *Phys. Rev. 76*, 641-6(1949) Sept. 1.

The β spectra of the forbidden transitions of Y^{91}, Sr^{89}, Y^{90}, Cs^{137}, Bi^{210}, Au^{198}, Re^{186}, and P^{32} have been measured with thin sources and high resolution. Forbidden type spectra are found for the first five. Allowed spectra were obtained for Au^{198}, Re^{186}, and P^{32}. Evidence is advanced for the reliability of the nuclear shell structure model and for the validity of the Gamow-Teller selection rules. The end-points found are: Y^{91}, 1.537 ±0.007 Mev: Sr^{89}, 1.463 ± 0.005 Mev; Y^{90}, 2.180 ±0.007 Mev; Cs^{137}, 0.51 ±0.01 Mev; Au^{198}, 0.956 ±0.00t Mev; Re^{186}, 1.063 ±0.006; and P^{32}, 1.689 ± 0.01 Mev.

1755 The beta-spectrum of tritium. S. C. Curran, J. Angus, and A. L. Cockroft. *Phys. Rev. 76*, 853-4(1949) Sept. 15 (Letter to the editor) (See also NSA 1-1476 and 2-968).

A previously reported investigation of the β spectrum of H^3 (*Nature 162*, 302(1948); *Phil. Mag. 40*, 53(1949)) has been extended and the shape of the spectrum near the end-point has been studied in greater detail. The proportional counter technique previously described (*Phil. Mag. 40*, 36(1949)) has again been used with a photographic method of recording and analyzing the output pulses. The experimental and theoretical Fermi curves of the end-point region have been calculated for neutrino masses of 0 and 1 kev. However, the line width is too large to allow a significant differentiation between the two cases.

1756 Evidence of the influence of the degree of ionization of the atom on the half-life of the nucleus Be^7. R. Bouchez, P. Daudel, R. Daudel, R. Muxart, and A. Rogozinski. *j. phys. radium 10*, 201-6(1949) June (in French) (See also NSA 1-1487).

Evidence is presented of a difference in half-lives of approximately 1% between two radioactive sources of Be^7, one in the elemental metallic state and the other in the form of a chemical compound (fluoride). The experimental study was made using a sensitive differential set-up, consisting of two identical ionization chambers and an electrometer tube functioning with an isolated grid. The result obtained gives adequate agreement with the theoretical estimates; but an exact theory of the phenomena encounters considerable difficulties.

1757 Inner conversion of gamma rays with pair formation in light elements. V. B. Berestetskiĭ and I. M. Shmushkevich. *Zhur. Eksptl. i Teoret. Fiz. 19*, 591-604(1949) July (in Russian).

Coefficients of inner conversion with pair formation are calculated for radiations of an electric and a magnetic multipole. The case considered is that of high-energy γ quanta emitted by nuclei with a small charge. The computation is based upon the work of Rose and Uhlenbeck, (*Phys. Rev. 48*, 211(1935)) who showed that, provided the energy changes are sufficiently great, tolerably accurate results can be obtained if calculations are made with the Born approximation, i.e., by neglecting the Coulomb field of the nucleus.

1758 Internal pair formation. M. E. Rose. *Phys. Rev. 76*, 678-81(1949) Sept. 1.

The electron-positron angular correlation and total conversion coefficient are calculated for internal pair formation and for an arbitrary multipole order of the electric and magnetic radiation fields. The Born approximation is used and in the region of greatest experimental interest, $Z \lesssim 40$ and γ-ray energy > 2.5 Mev, the consequent error should be negligible. Numerical results are given for multipole fields of order 2^l with $l = 1$ through 5 inclusive.

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1759 Radioactive tin 121, 123, 125. J. C. Lee and M. L. Pool. *Phys. Rev. 76*, 606-8 (1949) Sept. 1.

On the basis of an investigation of the tin isotopes produced by bombardment of tin enriched in its various isotopes, new data has been obtained. Slow neutron irradiation of tin enriched 83.1% in Sn^{124} resulted in an isotope of 9.8-min half-life which was identified as Sn^{125}; aluminum absorption measurements indicated a 1.3-Mev β particle end point. Fast neutron irradiation of a tin sample enriched in Sn^{124} was found to produce Sn^{123} with a half-life of 40 ± 1 min, a β end-point of 1.32 Mev, and associated γ radiation. The (d,p) reaction on tin enriched in Sn^{120} permitted the assignment of the observed 1.1 day activity to Sn^{121}; associated with this isotope was the emission of a negative particle of 0.35 Mev energy. When tin samples enriched in Sn^{120}, Sn^{122}, and Sn^{124} are bombarded with deuterons, the Sn^{122} sample yields a very strong 130-day activity. Neutrons from the Be(d,n) reaction induced the 130-day activity in the enriched Sn^{122} sample but not in the Sn^{120} sample. Fast neutrons from the Li(d,n) reaction induced the long period in the Sn^{124} sample only. The activity has been assigned to Sn^{123}; the reactions are $Sn^{122}(n,\gamma)$, $Sn^{122}(d,p)$, and $Sn^{124}(n,2n)$. The β end-point observed for this activity was 1.3 Mev. Finally, a tin activity with a half-life of 10 ± 0.3 days was obtained by deuteron bombardments of samples enriched in Sn^{120}, Sn^{122}, Sn^{124}, respectively, but the resulting intensity from the Sn^{124} sample was much stronger that the intensities induced in the Sn^{120} and Sn^{122} samples. Fast neutron irradiation of Sn^{124} also produces this activity which has been assigned to Sn^{125}; the reactions are $Sn^{124}(d,p)$ and $Sn^{124}(n,\gamma)$. The β end point has been determined as 2.1 Mev. The results obtained agree with those reported by previous investigators with the following exceptions: (1) the 1.3-Mev β end-point determination for Sn^{125} and (2) the 1.32-Mev β end point value for Sn^{123} (Newton and McDonald, private communication to G. T. Seaborg, *Revs. Modern Phys. 20*, 585(1948)).

1760 Simultaneous emission of two electrons during the radioactive disintegration of rubidium 87. O. Haxel and F. G. Houtermans. *Z. Physik 124*, 705-13(1948) Sept. (in German).

Using coincidence measurements, it is shown that at the transformation of Rb^{87} into Sr^{87} two electrons are emitted, of which one is the decay electron and the other is probably due to a 100% inner conversion of a nuclear γ radiation. The energy of one of the two components is very low, so that very thin Rb layers must be used for the complete recording. Since in the former studies these facts were not taken into account, the existing determinations of the half-life period of Rb, which are known also to disagree between them, should be revised. By taking into consideration the β-β coincidences, a half-life value of Ru^{87} is obtained that closely agrees with that found by geological methods. Similar β-β coincidences were observed with the 156-min product of Dy. No such coincidences were produced by Bi^{210}.

1761 An approach for the understanding of the general relativity theory. F. Hund. *Z. Physik 124*, 742-56(1948) Sept. (in German).

It is shown that the understanding of the general relativity theory can be facilitated by taking into account certain features of Newton's mechanics of moving systems.

1762 Einstein's work and the duality of waves and particles. L. de Broglie. *Revs. Modern Phys. 21*, 345-7(1949) July (in French).

The influence of Einstein's work on the photoelectric effect and of his theory of relativity upon the development of modern physics is traced.

1763 An elaboration of the Schrodinger formalism with applications to nuclear physics. J. W. Calkin. *Phys. Rev. 76*, 846(1949) Sept. 15 (Letter to the editor).

A set of postulates is described to be applied to the wave mechanics problem of two bodies whose intrinsic spin states are known. The Schrödinger formalism which permits the discussion of nuclear phenomena without a detailed potential-theoretic description of the forces between particles, but rather by boundary conditions imposed on the wave function on a surface in configuration space which contains the region in which nuclear interactions between the particles takes place, is used. More detailed investigations of the extension of the basic ideas to the case of several bodies and the introduction of spin coordinates will be reported later.

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1764 Forms of relativistic dynamics. P. A. M. Dirac. *Revs. Modern Phys. 21*, 392-9(1949) July.

For the purposes of atomic theory it is necessary to combine the restricted principle of relativity with the Hamiltonian formulation of dynamics. This combination leads to the appearance of ten fundamental quantities for each dynamical system, namely the total energy, the total momentum and the 6-vector which has three components equal to the total angular momentum. The usual form of dynamics expresses everything in terms of dynamical variables at one instant of time, which results in specially simple expressions for six of these ten, namely the components of momentum and of angular momentum. There are other forms of relativistic dynamics in which others of the ten are specially simple, corresponding to various sub-groups of the inhomogeneous Lorentz group. These forms are investigated and applied to a system of particles in interaction and to the electromagnetic field.

1765 Fourth-order corrections in quantum electrodynamics and the magnetic moment of the electrons. Robert Karplus and Norman M. Kroll. *Phys. Rev. 76*, 846-7(1949) Sept. 15 (Letter to the editor).

Dyson's procedure (*Phys. Rev. 75*, 1736(1949)), for carrying out the calculations of the quantum electrodynamics radiative corrections to any order, has been tested by applying it to a specific fourth-order calculation: first, to verify that no unforseen and insurmountable difficulties occur, and second, to obtain a quantity which could be subjected to comparison with experiment. The magnetic moment of the electron was computed by evaluating the fourth-order corrections to the energy of the electron in a weak quasi-homogenous electromagnetic field. For convenience the matrix element involved was divided into various transition schemes; the classification of Feynman and Dyson was used which groups together emission and absorption processes, and electron and positron states. The finite integrals over the momentum spaces of the virtual particles obtained were reduced by Feynman's techniques (Private communication) and from the final integration, the correction to the magnetic moment has been determined to be $-2.973(\alpha^2/\pi^2)$ Bohr magnetons.

1766 Interaction of configurations in the carbon atom. A. P. Yutsis. *Zhur. Eksptl. i Teoret. Fiz. 19*, 565-76(1949) July (in Russian).

Interactions of the following configurations of the carbon atom are theoretically discussed: $1s^22s^22p^2$, $1s^22p^4$, $1s^22s^22p3p$, and $1s^22s2p^23s$. Wave functions of the atom in these configurations are given. With the aid of one-electron wave functions, calculated by the method of a self-congruent field without quantum exchanges, a computation is made of the energy-matrix elements, both diagonal and joining different configurations of the same valency, and a solution is given of the secular equations of every term of the configurations.

1767 Localized states for elementary systems. T. D. Newton and E. P. Wigner. *Revs. Modern Phys. 21*, 400-6(1949) July.

An attempt is made to formulate the properties of localized states on the basis of natural invariance requirements. The principal requirement is that a state localized at a given point becomes orthogonal to all the undisplaced states localized at that point following a translation. It is found that the required properties uniquely define the set of localized states for elementary systems of non-zero mass and arbitrary spin. The localized functions belong to a continuous spectrum of an operator which is designated as the "position operator". This operator automatically has the property of preserving the positive energy nature of the wave function to which it is applied (and it should be applied only to such wave functions). It is believed that the development presented here may have applications in the theory of elementary particles and of the collision matrix.

1768 Non-linear field theories. II. Canonical equations and quantization. Peter G. Bergmann and Johanna H. M. Brunings. *Revs. Modern Phys. 21*, 480-7(1949) July. (See also NSA 2-1429).

A covariant field theory of the general type of the theory of relativity is brought into the canonical form and then quantized. Particles are assumed to be represented as singularities of the field. Two primary difficulties had to be overcome. First, the variational integral could be extended only over that space-time domain which is free of singularities. Since the location of the singular world lines cannot be known until after the integration if the field equations has been completed, a second set of coordinates, called "parameters", were introduced to serve as

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variables of integration and in terms of which the motions of the particles can be arbitrarily prescribed. The second difficulty arose in that the expressions for the canonical momentum densities cannot be solved with respect to the partial time derivatives of the field variables; this circumstance precludes the construction of the Hamiltonian by the usual methods. Nevertheless, it has been shown that a Hamiltonian exists, though it is not uniquely determined by the Lagrangian; this Hamiltonian contains an arbitrary linear combination of the eight algebraic relationships that exist between the canonical variables at each world point.The canonical field equations have the usual form. They are covariant if the choice of Hamiltonian is left open. The eight algebraic constraints on the canonical variables at each point are all integrals of the field equations. So are the Poisson brackets between the canonical variables (at the same time). When this system of equations and constraints is quantized, the property of general covariance can be used to carry out a proof of the covariance of the whole theory, including the commutation relations, that requires none of the computational effort usually required in theories that are merely Lorentz invariant. Once the system of equations has been completed, it turns out that the covariance goes much farther than was required originally. Because of the introduction of the parameters, the ordinary coordinates of space-time turn formally, at least, into dynamical variables, and the usual canonical transformations, with respect to which the theory is covariant, transform the coordinates, the original field variables, and the canonical conjugates of both together. The canonical conjugates of the coordinates are the expressions ordinarily interpreted as energy and momentum densities. The physical significance of these canonical transformations, which cause the world points to lose their identities, is not yet understood.

1769 Note on relativistic properties of self-energies. A. Pais and S. T. Epstein. *Revs. Modern Phys. 21*, 445-6(1949) July.

The relativistic transformation properties of the self-energy of elementary particles are considered for the case of a free electron of zero momentum. Attention is called to and aspect of relativistic theory which may be of some methodological use in obtaining insight into the evaluation techniques of Schwinger and into the alternative methods such as the use of Pauli's "regulators."

1770 On the decomposition of tensors by contraction. Giulio Racah. *Revs. Modern Phys. 21*, 494-6(1949) July.

The decomposition of tensors into irreducible representations of the orthogonal groups is calculated for three and four dimensions. The connection is shown with the problem of the allowed values of ordinary and isotopic spin for a given symmetry of the spacial eigenfunction of a nuclear system.

1771 On the divergence problem in the theory of quantized fields. Jerzy Rayski. *Acta Phys. Polon. 9*, 87-98(1948).

By a suitable change in the definition of the four-vector of charge and current density, a Lorentz-invariant formfactor has been introduced which removes the well known divergencies in the theory of quantized fields. Physically, this amounts to the introduction of an elementary length connected with the finite dimensions of particles. Connections are shown to the problem of field equations with higher derivatives.

1772 On the invariant regularization in relativistic quantum theory. W. Pauli and F. Villars. *Revs. Modern Phys. 21*, 434-44(1949) July.

The formal method of regularization of mathematical expressions of sums of products of different types of δ-functions is first applied to the example of vacuum polarization. It is emphasized that only a regularization of the whole expression without factorization leads to gauge invariant results. It is further shown, that for the regularization of the expression for the magnetic moment of the electron, a single auxiliary mass is sufficient, provided that different functions of the same particle (e.g., the photon functions $\bar{D}$ and $D^{(1)}$) are regularized in the same way and that the regularization of products of two electron functions is never factorized. The result is then the same as that of using Schwinger's method of introducing suitable parameters as new integration variables in the argument of δ-functions, without using any auxiliary masses.

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1773 On the postulational basis of the theory of elementary particles. H. J. Bhabha. *Revs. Modern Phys. 21*, 451-62(1949) July.

A set of postulates is formulated which leads to the relativistic wave equations of present quantum mechanics. The mathematical difference between the usual non-linear interaction terms and terms which introduce essential non-linearities in the equations is discussed. It is proved that every particle must possess an antiparticle unless at least one of the basic postulates is discarded. The connection between the rest mass of the particle, the minimal equation of the α matrices, and the general commutation relations of the α matrices is defived and discussed. It is proved that for a particle of spin 1/2 there is only one possible wave equation, while for a particle of spin 1 there are others besides the usual scalar and vector equations. One such example is given.

1774 On the wave-mechanical derivation of the statistical atom model. Imre Fenyes. *Z. Physik 125*, 336-46(1949) (in German).

Dirac (*Proc. Cambridge Phil. Soc. 26*, 376(1930)) and Brillouin (L'atome de Thomas-Fermi, Paris, Hermann, 1934) have shown that the fundamental equations of the statistical theory of the atom can be derived from wave-mechanical concepts. Following this method, Hellmann (*Acta Physiochim. U.R.S.S. 4*, 225(1936)) was able to introduce into statistics the quantum number l, and Weizsäcker (*Z. Physik 96*, 431(1934)) obtained improved approximations for the kinetic energy. The present author shows that the calculations of the last named investigators can be considerably simplified. A general and very simple procedure is shown for a wave-mechanical derivation of all statistical atom models. It is based upon the method developed by the following writers: Wentzel (*Z. Physik 38*, 518(1926)), Kramers (*Z. Physik 39*, 828(1926)), and Brillouin (Notions de mécanique ondulatoire, Paris, Hermann, 1932, p. 39). Using this method, the equations of the self-consistent field are approximately solved; an integration is employed instead of a summation, over the quantum states. The fundamental statistical equations are obtained from the variations of the corresponding energy expressions.

1775 Potential fields and the generalized gauge transformation in the theory of spin particles. Bernard Kwal. *J. phys. radium 10*, 189-94(1949) June (in French) (See also NSA 3-1307).

The wave functions of spin particles in the presence of sources take into account the potential fields and the generalized gauge transformations. In the most general case, the sources, fields, potentials, and the generating functions of the gauge transformation are represented by the complex homologues of the spinor magnitudes. The number of components of the potential fields is determined by the number of components of the source fields. The case of the particle of spin 1 is studied in detail and it is shown that the quadri-vectoral field, which it is necessary to associate with the field of an anti-symmetric tensor for the accurate description of a particle of spin 1 has nothing in common with the potential vector of Maxwell's theory. The two fields are derived from a potential field, a distinct magnitude, of which one part reduces to the potential vector of Maxwell when the mass of the particle of spin 1 becomes zero at the limit. Hence the description of a photon of zero rest mass requires the use of a ten-component field. The study of the equations for charged mesons in the presence of an external field can also be made with the aid of potential fields.

1776 Quantum theory of fields. Gregor Wentzel (translated from the German by Charlotte Houtermans and J. M. Jauch). New York, Interscience, 1949. 224p.

After a preliminary discussion of the general principles of quantum theory the following topics are treated: scalar fields, the vector meson field, quantum electrodynamics, and the quantization of the electron wave field according to the exclusion principle.

1777 Reciprocity theory of elementary particles. Max Born. *Revs. Modern Phys. 21*, 463-73 (1949) July. (See also NSA 3-857).

From the author's development of the reciprocity theory of elementary particles it is concluded that it is possible to modify the accepted laws of physics in such a way that they form a logically coherent system without infinities. The following topics are considered: (1) the general wave operators; (2) the conservation laws and field quantization; (3) the principle of reciprocity; (4) determination of the self-reciprocal functions; (5) the masses of mesons; (6) the electromagnetic field; (7) the electron; and (8) the nucleon. 18 references.

PHYSICS (continued)

1778 On relativistic cosmogony. G. Gamow. *Revs. Modern Phys. 21*, 367-73(1949) July.

An attempt is made to determine whether or not the problems of cosmology and cosmogony can be understood entirely on the basis of the general theory of relativity in its original form as proposed by Einstein. The following are considered: (1) the effect of the so-called "cosmological term" in the general equation of the expanding universe; (2) the consequences of relativistic cosmology with respect to the observed properties of our universe, as related to Hubble's studies of the red-shift and space density for very distant galaxies (The observational approach to cosmology. Oxford, Clarendon Press, 1937); and (3) the development of various characteristic features of our universe as the result of its expansion from the originally homogeneous state, and the theory of the origin of atomic species. The results obtained indicate that the use of the standard equations of the general theory of relativity aid in the understanding of the evolutionary features of our universe.

1779 Relativistic equations of motion of free dipole and quadrupole particles. Bronislaw Sredniawa. *Acta Phys. Polon. 9*, 99-108(1948).

A variational principle introduced by Mathisson (*Acta Phys. Polon. 6*, 163(1937)) for the derivation of equations of motion of multipole particles is applied here to a dipole particle characterized by a spin bivector $s^{\alpha\beta}$ and a dipole moment n^{α}. Solutions are given of equations corresponding to the case characterized by n^{α} only. Equations of motion of dipole-quadrupole particle are considered. A solution is given of the equations of motion of a quadrupole particle.

1780 Relativistic intensities of multipole radiation in the Lyman series. Jan Rzewuski. *Acta Phys. Polon. 9*, 71-86(1948).

Intensities of multipole radiation in the Lyman series are calculated by using Dirac's relativistic theory of the electron. Selection rules, the Zeeman effect, and the sum rules are deduced, and, as an application of the results obtained, the probability is calculated of the inversion of the spin vector under the influence of a magnetic field, for the state n = 1.

1781 Relativistic wave equations. E. P. Wigner. *Z. Physik*, 665-84(1948) Sept. (in German).

The quantum-mechanical approach to the relativistic one-body problem can be effected from two standpoints. An attempt can be made to find relativistically-invariant linear equations, whose solutions will represent a relativistically-invariant manifold describing the possible states of the system. Or else a direct determination of th linear manifolds can be attempted. In the present work the second method is used, so that the wave equation is derived later in the course of the computation, as the characteristic equation of the already known linear manifold. In the case of a finite mass, this second standpoint leads only to manifolds which have already been given in Majorana's equations (*Nuovo cimento 9*, 335(1932)). However, manifolds corresponding to a vanishing rest mass cannot be derived from those of a finite rest mass through a simple limit transition. For a given momentum, these manifolds contain either one or two only, or an infinite number of polarization states. The latter case is here given a special attention, the corresponding characteristic equations are derived, and the form of the scalar product determined, both in the space of momenta and in the coordinate space.

1782 Separation of the variables of the two-particle wave equation. Luther Pfahler Eisenhart. *Proc. Natl. Acad. Sci. U.S. 35*, 490-4(1949) Aug. (See also NSA 3-1498).

The separation of variables is accomplished for the wave equation of two particles at points P(x,y,z) and $\bar{P}(\bar{x},\bar{y},\bar{z})$, where x,y,z and $\bar{x},\bar{y},\bar{z}$ are rectangular Cartesian coordinates in Euclidean 3-space.

1783 A special method for solving the Dirac equations. A. H. Taub. *Revs. Modern Phys. 21*, 388-92(1949) July.

Exact solutions to the Dirac equations for an electron in an external field of an arbitrary plane wave are obtained by transforming plane wave solutions for a free electron by variable Lorentz matrices, such as occur in the discussion of the classical orbits. An example shows that this method, which applies classically, may fail for the Dirac equations when the external field is a constant one.

GENERAL

1784 Atomic energy and its utilization. Bernhard Bavink. Berlin, A. Francke, 1947. 104p. (In German).

The first part of this book is historical, recording the chemical and physical fundamentals of atomic science. The second part is on the modern atomic theory.

1785 Atomic energy yearbook. Edited by John Tutin. New York, Prentice-Hall, Inc. 1949. 237p.

This British work summarizes in non-technical terminology some of the various topics of interest with respect to nuclear science and its applications (primarily military). The history of the development of nuclear physics is traced. Reactor information is discussed and the by-products produced are considered. The possible economic consequences of the development of nuclear energy are reviewed and the applications of this development to ship propulsion. In addition, the following topics are treated: a survey of the development of nuclear energy in the various countries, legal aspects, design of installations and safety measures, medical applications of isotopes, research frontiers, and international control of atomic energy. Tables of the elements, the radioactive isotopes and of nuclear spin are included as well as lists of the national science academies and of current periodicals which contain material on nuclear science. A bibliography is included.

1786 The release of intra-atomic energy. I. I. Frenkel. Moscow, Publishing House of the Academy of Sciences of the USSR, 1946.. 120p. (In Russian).

This book presents, in a popularized form, the principles of atomic and nuclear physics. Its treatment embraces the structure of the atom and of the nucleus, nuclear particles, accelerators, and the principles of the operation of the Wilson cloud chamber. Radioactivity and nuclear reactions are also treated at some length..

1787 Second annual report of the atomic energy control of Canada. Ottowa, 1948. 16p.

The first complete year of the board's operations saw the completion of the N.R.X. pile at Chalk River and the program of research and isotope production well under way. Uranium prospecting and mining has been stimulated, cooperation with United Kingdom and United States authorities continued and extended, and grants-in-aid have been made to McGill, Saskatchewan, British Columbia, and Queen's Universities.

1788 USSR - underground atomic plant. *Mil. Rev. 29*, No. 3, 71(1949) June.

The Soviet Union is reported to have set up a large underground factory on the Sanga River north of Erivan to process uranium. Deposits of uranium are said to have been discovered in the area of Ossetia and in the northwestern part of the Georgian Soviet Republic. An accompanying map shows these locations.

1789 Radioactive contamination as a war weapon. Hans Thirring. *Flugwehr und Technik*, No. 8, 185-8(1948) Aug. (In German).

The writer speculates on the effect of the "death cloud" – a cloud of fine sand or dust, impregnated with radioactive substances, released and evenly scattered over enemy territory by long-range aircraft or rockets. He also lists fission products of U-235 suitable for the purpose.

BIOLOGY AND MEDICINE

1790 A fractionation procedure for the acid-soluble phosphorus compounds of liver. Jacob Sacks. AECU-466, nd. 15p. Proposed for publication in *J. Biol. Chem.*

A precedure based on the solubilities of the alkaline earth salts, has been described for the fractionation of the acid-soluble phosphorus compounds of liver for tracer experiments. The phosphorus of the following fractions is probably free, or practically free of other phosphorus compounds: inorganic phosphorus, adenosine tri- and diphosphates, phosphoglyceric acid, glycerophosphoric acid, propandiol phosphate, glucose-1-phosphate, and glucose-6-phosphate. A fraction containing principally adenylic acid, and one of which the major constituent is DPN, have also been obtained. These are known not to represent single phosphorus compounds.

The procedure has been applied to the livers of rats of the Carworth and Sprague-Dawley strains, and some differences have been found between these strains with respect to the amounts of phosphorus in the adenylic acid and glucose-6-phosphate fractions, and in the total acid-soluble phosphates. In the livers of the rats of the Sprague-Dawley strain, the amounts of

BIOLOGY AND MEDICINE (continued)

propandiol phosphate present have been found to fall into two distinct ranges, of which the higher is about four times the lower. The amounts of this substance found in the livers of the Carworth strain animals are in the lower range.

1791 Nucleoproteins and the cytological chemistry of paramecium nuclei. Montrose J. Moses. AECU-471. nd. 8p.

Quantitative cytological chemical analyses of the nucleoprotein composition of the macro- and micronuclei of a clone of *P. caudatum* show that both nuclei contain protein, ribose-nucleic (RNA), and desoxyribosenucleic acid (DNA) in the ratio of 20:2:1. Twice as much RNA as DNA was found. From their resemblances to the nucleoprotein contents of metabolic metazoan nuclei, it is concluded that in the vegetative stage, both nuclei of *P. caudatum* are actively metabolic.

1792 Inhibition of phosphatases by beryllium and antagonism of the inhibition by manganese. Kenneth P. DuBois, Kenneth W. Cochran, and Marcella Mazur. AECU-502, nd. 6p.

The results of experiments are described which demonstrate that beryllium inhibits alkaline phosphatases activated by magnesium and calcium and that this inhibition can be prevented and reversed by manganese. In order to ascertain the action of beryllium on a calcium-activated enzyme the adenosine triphosphatase system was employed, and the effect of beryllium on the adenosine triphosphatase activity of mouse liver and lung tissue was measured by the method of DuBois and Potter (*J. Biol. Chem. 150,* 185(1943)). For all of the tests aqueous solutions of beryllium chloride were employed. The inhibitory action of beryllium on adenosine triphosphatase activity is shown by data from which it may be seen that the activity of lung and liver tissue was inhibited to about the same extent by similar concentrations of beryllium. To compare the inhibitory action of beryllium on phosphatases activated by magnesium and calcium the effect of beryllium on the alkaline phosphatase activity of several tissues has been examined. Alkaline phosphatase measurements were performed using essentially the method of Bodansky (*J. Biol. Chem. 120,* 167(1937)) with modifications in the quantities of reactants to make the method suitable for small quantities of tissue. Magnesium-activated reactions appeared to be more sensitive toward the action of beryllium than calcium-activated reactions. Since manganese also activates alkaline phosphatases, tests were made of the inhibitory action of beryllium on serum phosphatase in the presence of various concentrations of manganese as manganese sulfate. When manganese and beryllium were present in the test system at the time of addition of the serum, manganese markedly decreased the inhibition produced by beryllium. It was also found that manganese was effective in antagonizing the action of beryllium when added to the reaction mixture 5 minutes after the beryllium and serum were mixed. Cobalt and nickel also antagonized the inhibitory effect of beryllium on serum phosphatase in vitro.

1793 Effects of acute beryllium poisoning on carbohydrate metabolism. Kenneth P. DuBois, John Doull, and Kenneth W. Cochran. AECU-503, nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

The occurrence of beryllium poisoning through the use of this toxic metal in several industrial processes has stimulated interest in the mechanism involved in its toxic action. In undertaking studies on the mechanism of action of beryllium we were interested in observing its effects on carbohydrate metabolism and on various enzymatic reactions.

For these studies aqueous solutions of beryllium chloride were administered intraperitoneally to rats and the LD-50 value was 0.6 mg/kg of beryllium. Following acutely toxic doses of beryllium a marked hyperglycemia occurred. In 6 hr after poisoning the blood glucose values had risen to 170 mg% after 2.5 mg/kg, to 270 mg% after 5 mg/kg, and to 300 mg% following 15 mg/kg of beryllium. The hyperglycemia could be prevented by insulin, ergotamine, or adrenal-demedullation indicating that the effect was induced by epinephrine. A 59% decrease in liver glycogen was observed in 5 hr after 7.5 mg/kg of beryllium and in 48 hr after this dose of beryllium depletion of phosphocreatine and a marked increase in inorganic phosphorus of the liver was observed.

Concentrations of beryllium as high as 1×10^{-3} M did not inhibit the oxidation of glucose or anaerobic glycolysis. Alkaline phosphatases activated by calcium or magnesium were strongly inhibited by beryllium.

BIOLOGY AND MEDICINE (continued)

1794 Observations on lung pathology following the inhalation of radioactive cerium. Hermann Lisco and M. P. Finkel. AECU-510(UAC-46), nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

Radioactive cerium (Ce^{144}) is one of the rare earths which is formed in the fission of uranium and of plutonium. It is a beta emitter (maximum energy 0.348 Mev) and it has a half-life of 275 days. Ce^{144} was adminstered to rats as an aerosol (CeO_2) in doses ranging from 3.2 to 200 μc per animal. Although the material was deposited generally in all lobes of the lungs, its distribution was not uniform. Radioautographs showed small and large, irregularly distributed foci. A considerable portion of the inhaled cerium remained in the lungs. However, in addition to excretion, some translocation occurred primarily to the liver, kidneys, and skeleton.

Histologic examinations were made of the lungs of most of the animals, especially those surviving beyond 200 days. The lesions observed will be discussed and illustrated.

Particular emphasis will be placed on the occurrence of metaplastic changes in the bronchial epithelium and on malignant tumors arising therefrom.

1795 Beryllium poisoning. Robert J. Hasterlik. AECU-522(UAC-90), nd. 10p.

The history of beryllium poisoning, which was first evident in 1931, following development of methods for production of beryllium on a large scale, is traced. Of special interest to physicians are two features: the extremely minute quantities of the chemical which can cause poisoning, and the long, latent period often seen between the last exposure to beryllium compounds and the development, years later, of the form of the disease known as "delayed pulmonary granulomatosis." It is the form of the illness called either "delayed chemical pneumonitis" or "chronic pulmonary granulomatosis" which has proven to be the greatest challenge to the medical profession. The intensity of the delayed reaction and the peculiarities of the clinical picture make it unique. It should be understood that this is a disease of the entire body although the most prominent and incapacitating features are centered in the respiratory system. Exposure to the following compounds have produced various forms of beryllium poisoning: beryllium oxide, fluoride, sulfate, chloride, oxyfluoride, carbonate, hydroxide, manganese silicate, zinc magnesium silicate, and finely powdered beryllium metal. The sulfate, fluoride, oxide, metallic dust, and perhaps the hydroxide have been shown to produce the acute disease. Tracer studies on animals with Be^7 indicate that a large and very significant portion of the injected dose of a soluble salt is rapidly deposited in the bone where it remains almost indefinitely. After a very short period of excretion in the urine, insignificant amounts leave the animal's body. This finding of deposition in bone may give a possible clue as to the mechanism of the delayed appearance of the disease. It is conceivable that various "trigger mechanisms" act to release beryllium stored in the bones into the general circulation. It is not possible at present to set "safe" air levels. It is known that exposure to air concentrations of a beryllium compound containing 25 μg of beryllium per cubic m of air has produced the acute form of the disease. This, then, represents a level which never could be permitted. Work with beryllium should never be carried out in an open room. Contamination of air, table tops, and apparatus can serve as a silent and potent source of beryllium; enough to cause disease in the scientist himself and in his fellow worker or laboratory neighbor. All procedures should be carried out in a ventilated "dry-box", shielded and ventilated machining devices, or ventilated hoods. Exhaustion from the hood should not be ignored as it constitutes a potential hazard on discharge from the ventilating stack. Filtration systems should be present in the exhaust ducts to trap the particles, especially those below one micron in size, before discharge of this air to the outside. This places a heavy financial and technical burden on all contemplated work with beryllium. There must be continuing dissemination of knowledge concerning beryllium poisoning among all members of the medical profession so that the diagnosis is not confused with other disease (as it quite understandably was in the early days); so that the early symptoms of its onset are not missed.

1796 A source of error in tracer experiments with P^{32}. B. A. Rubin. AECU-473, nd. 3p. Proposed for publication in *J. Biol. Chem.*

This is not an abstract; the document is reproduced below in its entirety.

In dealing with radioactive solutions of high specific activity, where total phosphorus is small, the amount of P^{32} adsorbed on laboratory glassware may become significant. An experiment done in this laboratory to measure this effect and to determine the efficacy of silicone coated glassware illustrates the magnitude of the problem.

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A solution of P^{32} containing about 1 x 10^{-4} mg/ml. of total phosphorus was drawn up once into each of four 2-ml pipettes, all new and identical, but two of which had been silicone coated. Each of the pipettes was then washed by drawing up 2-ml amounts of distilled water. The wash water from each pipette was collected into two counting sample cups (1 ml each), evaporated, and the number of radioactive disintegrations determined in a "Nucleometer".

Average values, in cts/min/ml were:

	Coated	Uncoated
Wash 1	390	6,000
Wash 2	110	300
Wash 3	background	100

The count in the first wash of the uncoated pipette is high and variable depending on both the P^{32} and P^{31} contents and can cause serious error where it is not suspected.

To avoid this difficulty, we have adopted several techniques. 1. Wherever possible all counting solutions contain a uniform 1 mg/ml of carrier phosphorus at pH 4.5. 2. Where less carrier must be used, care is taken to pipette as rarely as possible and only in solutions containing as much carrier as the procedure permits. 3. When conditions are extremely unfavorable, requiring exceedingly low carrier or high pH values, silicone coating of glassware is necessary.

The coating technique we used was modified from Johannson and Torek (*Proc. I.R.E. 34*, 296 (1946)). A 2% solution of "DC 200" was prepared in pure grade CCl_4 (The Dow Company recommends chlorinated organic solvents). The glassware (preferably new) is scrupulously cleaned and heat dried, completely immersed in the silicone solution, and carefully drained. It is then placed into an oven at 90°C for 2 hr, to evaporate the solvent. The temperature is then raised to 250°C for a period exceeding 4 hr but not longer than overnight. Detailed experiments on the lasting qualities of this type of coating have been done by the Dow Company. This treatment caused no detectable change in calibration.

There is another group of compounds which have been similarly used, called "silanes" (hydrochlorides of unpolymerized silicones). These may be vaporized on to a glass surface where they react with the film of moisture to form a silicone layer. This process of hydrolysis and polymerization is somewhat difficult to control.

1797 Hemoglobin labeled by radioactive lysine. Erythrocyte life cycle. W. F. Bale, C. L. Yuile, L. DeLaVergne, L. L. Miller, and G. H. Whipple. AECU-489, nd. 10p.

A dog, doubly depleted of blood cells and plasma proteins, was fed DL-lysine labeled with C^{14} in the epsilon carbon position. In the first 8 hr 28% of the administered C^{14} was excreted in the urine; in the first 72 hr, 35%. Twenty-four hr after feeding, 4.2% of the fed C^{14} was circulating in the plasma, decreasing to 1% at the end of 17 days. The C^{14} content of the blood cells increased from 1% at 24 hr to 5.5% in 5 days and 6.8% in 22 days.

Evidence based on the rate of decrease of the C^{14} content of circulating blood cells is presented indicating an average life of 115 days for the erythrocyte protein as an entity not interchanging with extracellular constituents. This closely corresponds to the life span of the dog erythrocyte, 112-133 days according to the best evidence otherwise available, and indicates that this experiment has actually measured the life span of the dog erythrocyte. On the breakdown of blood erythrocytes the protein comprising them is not used preferentially for the formation of new erthrocytes.

1798 Radioactive lysine in protein metabolism studies. Synthesis and utilization of plasma proteins. L. L. Miller, W. F. Bale, C. L. Yuile, R. E. Masters, G. H. Tishkoff, and G. H. Whipple. AECU-490, nd. 29p.

Racemic lysine labeled with C^{14} in the epsilon carbon position was fed to dogs. The distribution of C^{14} in blood and tissue fractions is recorded. In normal dogs sacrificed at 24 hr, approximately one-third of the C^{14} was found in the urine, one-third in expired air, and one-third in the body, mostly in protein, predominantly as lysine residues. The rate of C^{14} excretion as CO_2, hr by hr, paralleled closely the amount of non-protein C^{14} in the blood plasma. The liver, kidney, pancreas, and spleen all have high values for C^{14} in 24-hr and 17-day experiments. The gastro-intestinal tract is significantly high in the 24-hr experiments.

Plasma protein from animals previously fed C^{14} containing lysine and thus in turn labeled, was transfused into other dogs and the rate of disappearance of albumin and globulin fractions from the circulation of the recipient dog followed. The results lead to the conclusion that as a

BIOLOGY AND MEDICINE (continued)

whole, plasma proteins are utilized and replaced at a rate of at least 10%/24 hr. This minimum rate is substantially faster than turnover rates commonly accepted and emphasizes the role played by the plasma proteins in the protein economy of the body. The exact rate determination is made uncertain by the lack of knowledge of the magnitude of the amount of protein in solution in extracellular and lymph spaces and its rate of equilibrium with circulating plasma proteins.

Evidence from these transfusion studies indicates that plasma globulin is metabolized at a significantly faster rate than plasma albumin. This is confirmed by the observation that following the feeding of labeled lysine to dogs, C^{14} is first incorporated in globulin in high concentration but that later it also disappears more rapidly from the globulin fraction. These data suggest that the period of bone marrow maturation of the red cell during which time its related hemoglobin is synthesized does not exceed 3 to 5 days.

1799 Absorption and excretion of carbon^{14} as CO_2 and bicarbonate. Austin M. Brues and Agnes Naranjo. AECU-509(UAC-45), nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

As shown previously, the mouse exposed to $C^{14}O_2$ in a closed system rapidly attains a steady state in which the C^{14} in the animal approximates the amount originally in a volume of air ten times the volume of the mouse. This labile carbon compartment appears to be somewhat greater than the inorganic body carbon, excluding bone carbonate. Excretion rates after a 30-min. confinement period show a small portion of the body C^{14} to be in somewhat more stable combination.

Because of the great rapidity of absorption of $C^{14}O_2$, we have measured the clearance of the tracer gas from air breathed through a tracheal cannula by rats under Nembutal anesthesia. Initially, the expired air contains less than one-half the $C^{14}O_2$ concentration of the inspired air, although the CO_2 concentration is naturally much higher.

To make conditions as favorable as possible for fixation of C^{14}, mice were injected with labelled sodium bicarbonate and allowed to rebreathe expired air for 10 hr in a 20-liter chamber. Various tissues were analyzed at intervals up to 2 months after removal. It is estimated that less than 2% of the body carbon had exchanged with blood bicarbonate at the end of exposure. Of this retained carbon, about 90% was lost within a week; beyond this time the rate of loss was relatively slow.

Newborn mice receiving C^{14} by exposure of their mothers prior to delivery lose C^{14} much more slowly than adult mice, but the specific activity of their body carbon decreases rapidly due to growth.

1800 Body retention of carbon 14 from labeled sodium bicarbonate. Howard E. Skipper, Locke White, Jr., and Carl E. Bryan. *Science 110*, 306-7(1949) Sept. 23. (See also NSA 3-1330).

The experiments reported here present data on $C^{14}O_2$ fixation, from which the average body radiation was calculated. Twelve mice were injected intrapertioneally with a solution containing 2.5 mg of $NaHC^{14}O_3$ and a total activity of 18 mμ. The expired CO_2 was collected from the animals over varying intervals and two mice were sacrificed for tissue and organ analysis at 24 hr, 48 hr, 1 week, 2 weeks, 4 weeks, and 3 months; the C^{14} assays were carried out on pooled blood, spleen, liver, kidney, lung, brain, small intestine, muscle, skin and hair, and bone samples. No outstanding selective accumulation of C^{14} from a gross anatomical standpoint was observed, but it was noted that the rate of uptake and loss of C^{14} by the jejunum was significantly greater than other tissues studied. It is concluded from the body radiation data on the mice that the average overall body radiation from bicarbonate is apt to be lower than the tolerance level of 0.1 rep/day for man unless doses of 5 mc or more are given.

1801 Concerning the mammary excretion of radioactive iodine after the administration of labeled iodides or iodocasein. R. Courrier, J. Roche, G. H. Deltour, M. Marois, R. Michel, and F. Morel. *Compt. rend. soc. biol. 144*, 599-601(1949) May (in French).

Lactating rabbits were injected intraperitoneally with iodocasein and potassium iodide labeled with I^{131} and the method of iodine fixation in the breast-fed young was studied. The breast milk transmitted a minimal fraction of the labeled iodine derived from the iodide to the young; iodocasein provided an even smaller amount of traceable substance. It was determined that the thyroid gland of the breast-fed animal fixed the iodine received into the iodide form.

BIOLOGY AND MEDICINE (continued)

1802 Development in radioactive tracer methods. W. J. Arrol. *Research* 2, 253-9(1949) June.

Recent developments in the techniques used with radioactive tracers are reviewed. The following topics are treated: (1) the labeling of elements and compounds, (2) the preparation of radioisotopes, (3) radioactive assay, (4) synthesis of labeled compounds, (5) tracing an element on the macroscopic scale, (6) tracing an element on the microscopic scale, (7) identification of a labeled compound, and (8) dilution technique in quantitative analysis. In addition, the following types of kinetic studies in living organisms, which have been made with biological tracers, are treated: the determination of turnover rate, the determination of the life span of the red blood cell, and the study of the biological precursors of compounds. 36 references.

1803 Distribution of P^{32} in chick embryos. J. B. O'Neil, J. R. Jowsey, C. C. Lee, and J. W. T. Spinks. *Can. J. Research* 27, 223-32(1949) Aug.

The distribution of P^{32} in the eggs of chickens was investigated; a Barred Plymouth Rock hen was given a daily dose of 2.12 mc P^{32} mixed in her feed in the form of labeled potassium dihydrogen phosphate. The eight eggs laid in the first two weeks following the first feeding were analyzed for total activity in the white yolk; eleven subsequent eggs, all fertile and laid between the 15th and 46th day after the first feeding, were incubated under standard conditions, and the chicks which perished during or after incubation were analyzed. Droppings from the two remaining chicks were also analyzed. From the embryos and chicks that were analyzed, radioactivity was found in all fractions examined; the greatest amount of radioactivity was found in the fractions which normally contain the highest concentrations of phosphorus. The authors conclude that the radioactivity had no influence on the hatching of the egg and the normal growth of the chick. The observed high specific activity of the embryonic fluids and membranes fraction suggests that phosphorus compounds of high specific activity in the egg, such as the vitellin, may be hydrolized to inorganic phosphate, transported to the allantois and then absorbed by the embryo. More experiments are being carried out. 10 references.

1804 Exchange of materials in a lake as studied by the addition of radioactive phosphorus. C. C. Coffin, F. R. Hayes, L. H. Jodrey, and S. G. Whiteway. *Can. J. Research* 27, 207-22(1949) Aug.

The results of an experiment determining the rate of uptake of radioactive phosphorus P^{32} by certain organisms situated in a small lake are presented. One hundred mc of P^{32} was added directly to the surface of the water in the acid bog lake, which had a layer of cold, stagnant water at the bottom with a thermocline above. Within a few hours the P^{32} was taken up by the sphagnum by the floating plankton, and by sponges. Within a few days radioactivity was noted in the bodies of fish (Fundulus and Notemigonus), and within two weeks it had accumulated in their viscera and skeletons. Penetration of the radioactivity into the lake depths was slow and no appreciable uptake by bottom-rooted plants was noted for more than two weeks after the introduction of the isotope. It was shown that Zooplankton and Fundulus absorbed most of the radioactivity; algae and other forms demonstrated minimal concentrations.

1805 The exchange of phosphate between the blood and the eye, studied with the aid of radio-autographs. Erik Palm. *Acta Ophthalmol.* 27, 267-74(1949).

A series of radio-autographs were made in connection with a comprehensive study of the exchange of phosphate between the blood and the eye; P^{32} was injected intraperitoneally into guinea-pigs, the animals were killed after an experimental period of 1-1½ hr, and their eyes were frozen and sectioned. The sections were then placed in contact with photographic film which was darkened by the radioactive material, and the pictures obtained in this manner give a direct indication of the distribution of the newly introduced phosphate in the eye at the moment of death. A brief analysis is made of the significance of the pictures in relation to certain outstanding problems in eye physiology.

1806 Excretion of radiocalcium by normal rats. Maurice V. L'Heureux, Wilbur R. Tweedy, and Elinor M. Zorn. *Proc. Soc. Exptl. Biol. Med.* 71, 729-32(1949) Aug.

The present study investigated the amounts of radiocalcium (Ca^{45}) excreted in the feces and urine and distributed in the tissues and contents of the gastro-intestinal tract a few hours after the administration of varying amounts of labeled calcium. Young adult rats of the Sprague-Dawley strain were used; each animal was given a small cutaneous injection of labeled calcium, (3-10 μc of Ca^{45}); at the end of the experimental period the animals were sacrificed and their parts were assayed for radioactivity. It was indicated from the results that the amount of labeled

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calcium injected is an important factor in determining the relative amounts of radiocalcium excreted in the urine and feces; when the quantity of labeled calcium injected was increased from 0.07 mg to 14 mg the fraction excreted in the urine climbed to a level almost equal to that of the feces. The results of experiments determining the one, three, and six-hour levels of radioactivity in the tissues and contents of the gastro-intestinal tract indicate that there is little active excretion of calcium through the wall of the large intestine.

1807 The fate of utilized molecular oxygen and the source of the oxygen of respiratory carbon dioxide, studied with the aid of heavy oxygen. Nathan Lifson, George B. Gordon, M. B. Visscher, and A. O. Nier. *J. Biol. Chem. 180*, 803-11(1949) Sept.

Two types of experiments on mice and rats employing a closed metabolism system were carried out with O^{18}: that in which the atmosphere was enriched with O^{18}, and that in which the body water was enriched with H_2O^{18}. It was found that the oxygen in respiratory carbon dioxide is in isotopic equilibrium with the oxygen of body water, and that at least a large majority of the utilized oxygen is soon converted to body water.

1808 The intermediary metabolism of phenylalanine labeled with radioactive carbon. Bernard Schepartz and Samuel Gurin. *J. Biol. Chem. 180*, 663-73(1949) Sept.

Two types of radioactive DL-phenylalanine were synthesized; one was labeled with C^{14} in the carboxyl and α positions of the side chain, while the other preparation contained C^{14} in positions 1, 3, and 5 of the aromatic ring. The conversion of both types of phenylalanine to acetoacetate in phlorhizinized animals as well as in rat liver slices was investigated. In the two experiments reported on intact rats, glycosuria was produced by the daily, subcutaneous injection of phlorhizin in oil at a dosage of 120-200 mg/kg body weight. When considerable amounts of glucose and ketone bodies were being excreted, the phenylalanine to be studied was injected intraperitoneally in divided doses (total dose of 100 mg); the collection of respiratory carbon dioxide was then made and urine samples were preserved. The α-carbon atom of phenylalanine was shown to be the precursor of the carboxyl carbon atom of acetoacetate. Direct evidence was obtained for the shift of the side chain of phenylalanine prior to the formation of acetoacetate; the terminal carbon atom of acetoacetate was shown to come from carbon atom 1 or 3 of the ring of phenylalanine; the carbonyl carbon atom of acetoacetate is derived from carbon atom 2 of the ring. It was demonstrated in several ways that the aromatic ring of phenylalanine undergoes metabolic cleavage and can be oxidized to carbon dioxide; the absence of significant randomization of isotope in the acetoacetate produced from phenylalanine indicates that a 4-carbon precursor of acetoacetate is involved; this precursor derives half of its carbon atoms from the side chain and the other half from the aromatic ring. 31 references.

1809 Methods for the determinations of radioactive phosphorus (P^{32}) in body fluids. Margaret A. Adams, Stanley M. Levenson, Rex G. Fluharty, and F. H. Laskey Taylor. *J. Lab. Clin. Med. 34*, 1301-11(1949) Sept.

Some methods are described for the determination of radioactive phosphorus, P^{32}, in plasma, red blood corpuscles, and urine following the intravenous injection of 100-200 μc of the isotope in normal human subjects; these methods also are applicable to in vitro experiments. The separation of the total acid-soluble and inorganic phosphate fractions of plasma and red blood corpuscles is described and the procedures used for preparing and counting radioactive samples from these fractions are given; losses of radioactivity by self absorption in thick samples are discussed. It is concluded that certain correction factors are necessary for the comparison of counting rates obtained in samples possessing different physical characteristics; the derivation and use of such correction factors are discussed.

1810 The use of radioactive isotopes in the study of peripheral vascular disease. Frederick W. Cooper, Jr. *Southern Med. J. 42*, 870-3(1949) Oct. (See also NSA 3-275).

The results of studies involving the use of radioactive sodium chloride are presented and four representative cases are described. A Geiger counter was placed posterior to the gastrocnemius muscle in each experiment and a radioactive solution containing 10 mc of radio-sodium chloride in 1-2 cc of solution was injected into the area; an indicator automatically recorded the rate that the radioactive sodium was being mobilized and removed from the site. This rate was compared with standard values derived, and was used as a diagnostic indication of the presence of peripheral vascular disease. The amount of radioactive material was small in all cases so as to prevent the radioactivity already released into the blood stream and recirculated from affecting the continuous

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readings being taken at the injection site. The methods of calculation and plotting of a mathematical value representing the rate corrected are described. It is believed that the method presented here provides a means for the accurate calculation of the effective blood flow in the extremities, and may be used as a procedure for diagnosis of vascular disease and as a method of evaluating the effects of surgery and other forms of therapy on vascular conditions.

1811 Increased seed germination following x-ray treatment of potato tubers. A. H. Sparrow, E. Christensen. AECU-484, July 12, 1949. 3p.

Potato tubers of the Katahdin variety were irradiated with 160 kvp x-rays at dosages varying from 75 to 2400 r. Seeds from plants produced by the tubers were collected and planted. No interesting mutations were found, but seeds from tubers irradiated with 150 r and 300 r showed a much higher percentage germination, as well as much faster germination, than seeds from untreated tubers.

1812 Influence of a conditioning injection of estrogen on the hematologic and organ weight response to x-irradiation. Harvey M. Patt, Marguerite N. Swift, Robert L. Straube, Ella B. Tyree, and Douglas E. Smith. AECU-487(UAC-38), nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

Estradiol benzoate (0.166 mg I.M. in a single injection 5-15 days before exposure) greatly enhances resistance of mice to total-body x-irradiation. Progesterone and testosterone are ineffectual. To elucidate this phenomena we have studied the effect of estradiol on organ weights, blood count, and microscopic anatomy in control and irradiated mice. Estrogen increases adrenal weight by 35-40% 4 days after injection and accelerates thymic involution but has no appreciable effect on weight of spleen, inguinal nodes, or kidney. Leukopenia with maximal depression around 10-14 days after injection has also been observed. Decreases are noted in lymphocytes and heterophils. Little change is seen in erythrocytes. Significantly, the maximal estrogenic protective effect is observed when mice are irradiated during their leukopenic period. Estrogen injection at the time of irradiation or 25-35 days before exposure does not protect. Radiation-induced involution of spleen, thymus, and inguinal nodes is not altered by estradiol. However, the increase in adrenal weight is somewhat greater in these animals. Leukocytes are decreased equally in both estrogen and control (sesame oil injected) irradiated animals, although maximal depression and recovery occur somewhat earlier in the former. Erythrocyte count of irradiated controls is decreased by 45% at 11 and 14 days after exposure. Estrogen-treated animals manifest a smaller decrease in red count (25%) 7 days after irradiation and normal levels at 11 and 14 days. The possibility that the protective action of estrogens is mediated by the adrenals is being investigated.

1813 Analytic study of effects of various patterns of x-irradiation on survival. George A. Sacher, John Sackis, and Austin M. Brues. AECU-488(UAC-39), nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

1600 female CF-1 mice were treated with 250 kv total-body x-radiation according to the following dosage patterns: 400 r in a single dosage, or in 10 or 40 daily treatments; 800 r in 10 or 40 treatments; 1200 r in 40 treatments, 5 r daily throughout life; 800 r in 40 treatments superimposed upon 5 r daily throughout life. There were 1400 control mice. Gross mortality rates have been computed as a function of time, in addition to rates associated with certain prominent types of pathologic change. As a general rule, all patterns of treatment increase the incidence of all types of pathology at all ages. The effect of radiation on rates of mortality is best expressed by means of the Gompertzian diagram (logarithm of rate of mortality against time). In this form, all categories of pathology in control animals show a linear increase with age, as is well known in the case of many human diseases. A dosage administered to young adult mice within a short interval (weeks) displaces these lines upward by a constant amount. The incidence of lymphoid tumors is phasic and constitutes an exception to this rule. The effect of daily small exposures throughout life combined with a heavy exposure early in life is discussed in terms of gross mortality excluding lymphoid tumors. To a first approximation, the results are additive on the Gompertzian diagram. The results indicate lines along which a calculus of radiation mortality may be developed for arbitrary time patterns of exposure.

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1814 Analysis of lymphoma induction by x-rays in mice. George A. Sacher and Austin M. Brues. AECU-493(UAC-62), nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

CF-1 female mice 120 days of age were treated with total body x-rays, using single and daily fractionated dosages between 400 and 1200 r. The incidence of lymphoma was determined (grossly at autopsy) and studied as a function of time and treatment. The total cumulative incidence is determined by the size of the dose and the fractionation pattern. When the logarithm of the rate of morbidity is plotted against time after treatment, a set of curves is obtained which is characterized by a peak in morbidity a few months after treatment, with a subsequent approach to the normally rising control morbidity curve. The incidence a year or more after treatment is little in excess of that of controls of the same age. When the morbidity rates are considered as the sum of the normal age incidence and the superimposed carcinogenic response, it is found that the carcinogenic response curve changes in amplitude (but not in form) with alterations in the dosage.

1815 Age and lymphoma incidence in CF-1 mice. Austin M. Brues, Miriam P. Finkel, Hermann Lisco, and George A. Sacher. AECU-494(UAC-63), nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

Two large groups of CF-1 female mice have been maintained throughout life as controls for radiation experiments. The median life span of these animals is about 600 days and about 1% survive beyond 850 days.

Throughout most of life, the susceptibility to lymphoma and lymphatic leukemia is approximately doubled at intervals of 75 days. After this time, no further increase in morbidity rate is observed. This pattern of incidence is similar to that seen in the case of many human tumors.

1816 Further studies on the clotting disturbance in the dog exposed to 450 r x-radiation. J. Garrott Allen, Katherine Lathrop, and Margaret M. Sanderson. AECU-496(UAC-56), nd. 12p.

This report is primarily concerned with the disturbance in the clotting time (plasma factors) incident to a radiation exposure. It has been previously reported that an anticoagulant similar to heparin can be demonstrated in the blood of dogs after lethal x-irradiation. Although the chemical identity of this material is not known, it is characterized by certain reactions which suggest that its nature is heparinoid. These studies have been extended, and data are presented which further suggest the possible heparinoid nature of the anticoagulant found in the blood after irradiation. Other nonheparin anticoagulants may be liberated, but thus far none has been found in the irradiated dog. Thrombocytopenia and capillary damage are also present and may contribute to the hemorrhagic state.

1817 Shrinking and swelling after alpha irradiation of various parts of large erythrocytes. Ralph Buchsbaum and Raymond E. Zirkle. AECU-501(UAC-114), nd. 8p.

Erythrocytes from Amphiuma and from man were irradiated in vitro with polonium α particles (a) from an extended source (4 mm in diameter) and (b) with a small beam (20μ in diameter). Microscopic changes have been observed in individual cells before, during, and after irradiation. The cells first shrank then swelled and hemolyzed. Local irradiation of a part of a single cell resulted in shrinkage only in the irradiated portion. This was followed by swelling of the whole cell and emolysis.

1818 Peripheral vascular reactions in the wing of the bat after total-body x-irradiation Douglas E. Smith, George Svihla, and Harvey M. Patt. AECU-506(UAC-40), nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

A number of peripheral vascular reactions (erythema, hyperemia, increased capillary fragility, hemorrhage) have been described in man and laboratory animals following exposure to x-radiation. In the hope of obtaining a definite picture of the development of these phenomena, microscopic observations and cinema microphotographs were made of vascular beds in the wing of the living, intact bat (*Myotis lucifugus*) before and at various intervals after total-body x-irradiation. Studies were made on several hundred animals during the late autumn and winter. Until high dosages (10,000 - 60,000 r) were reached no peripheral vascular changes were observed. Within an hour after such dosages large numbers of leukocytes, many of which stuck to the vessel walls, were apparent. This phenomenon which was most marked during the first 24 hours after irradiation persisted for several days. Early after irradiation the blood seemed to be less viscous than

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normal only to become more viscous at the end of 24-36 hours and remain so until death. Consistent changes in vessel diameter, blood flow, and venomotion were not observed, nor were any indications of hemorrhage. Toxicity experiments suggested that the bat might be highly resistant to x-irradiation, for in these experiments life span was shortened only after dosages of 15,000 - 60,000 r. Significantly, only such high dosages produced the peripheral vascular changes noted above.

1819 Oxygen consumption and water balance in the x-irradiated frog. Harvey M. Patt, Marguerite N. Swift, and Ella B. Tyree. AECU-507(UAC-41), nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

As a part of a study of the radiation response of frogs and of factors contributing to their radiosensitivity, we have investigated 1.) oxygen consumption after x-irradiation and 2.) rate of water uptake in dehydrated irradiated frogs. Oxygen consumed by individual unfed Autumn frogs, sedated with nembutal, was measured volumetrically at atmospheric pressure and 23°C. Results of a pilot study in which determinations were made during a control period of several days and at frequent intervals after x-irradiation with 300 r (completely lethal, mean survival time 26 days), suggest a slight early decrease in oxygen consumption with maximal depression (34%) 15 days after exposure. This is followed by return to control levels (0.086 ± .002 cc/gm/hr) around 25 days after irradiation. Although there is evidence that ionizing radiation accelerates catabolism in mammals, especially terminally, we failed to observe any increase in oxygen consumption in these frogs. Body weight of unfed irradiated frogs also did not change appreciably. Frogs kept in dry individual containers at 23° C for 3 days lose 35-40% of their water. After irradiation with 3000 r and immediate return to water, such partially dehydrated irradiated frogs regain water at the same rate as non-irradiated controls. In both groups, recovery is essentially complete by 4 hrs. There is no change in water content of non-dehydrated irradiated frogs over this period. Experiments are in progress to evaluate the influence of water content at the time of exposure on radiosensitivity in the frog.

1820 The relative biological effectiveness of beta radiation as shown by the radiotoxicity of Na^{24} for mice. Robert H. Snyder and Walter E. Kisieleski. AECU-523(UAC-91), nd. 10p.

Since sodium is distributed fairly uniformly throughout the body, radioactive sodium approaches the total-body type of irradiation produced with x-rays. Therefore, a comparison of the relative biological effectiveness of β rays and x-rays can be made. Mice were injected intraperitoneally with doses of radioactive Na^{24} ranging from 12 to 150 μc per g of body weight. The 20-day LD_{50} was found to lie between 20 and 40 μc per g, the final value arrived at by interpolation being 30 μc per g. The calculated radiation dosage corresponding to this 20-day LD_{50}, considering excretion and decay, was 680 rep.

About 30% of the injected dose was excreted in the first 24 hrs and 50% in 72 hrs, with the amount of NaCl included in the injection ranging from 0.5 to 1.5 mg per g. Discounting the systematic errors and the uncertainty for x-ray comparison under the conditions used, it was found that the ratio of x-ray to β-ray effectiveness is approximately 1.4. 14 references.

1821 Influence of estrogens on the acute x-irradiation syndrome. H. M. Patt, R. L. Straube, E. B. Tyree, M. N. Swift, and D. E. Smith. AECU-524(UAC-92), nd. 27p.

The phenomenon of estrogen protection against x rays has been investigated. Several types of experiments were performed. The following results are reported. Pretreatment with estradiol benzoate improves the survival of male mice after lethal x-irradiation has been confirmed. It has been demonstrated further that the estrogen protective effect occurs in female mice as well and that benzestrol, but not progesterone and testosterone, is also effective. The time of injection of estrogen relative to the time of irradiation is critical, for estradiol is most effective when it is given 10 days before the exposure. Estrogen injection 5 or 15 days before irradiation also protects but administration at other intervals fails to increase survival and, indeed, may even potentiate toxicity. Estradiol in dosage sufficient to protect against x-rays does not influence survival after poisoning with a nitrogen mustard. Estradiol (0.166 mg per mouse I.M.) increases adrenal weight and accelerates thymic involution but has no appreciable effect on weight of the spleen, inguinal nodes or kidneys. Although the increase in adrenal weight after x-irradiation is somewhat greater in mice pretreated with estrogen, the radiation-induced involution of spleen, thymus, and inguinal nodes is not altered by the treatment.

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A leukopenia with maximal depression around 10 to 14 days after estrogen injection has been observed. The reduction in heterophils is more marked and somewhat more consistent than the lymphocyte response. Little change is noted in erythrocyte count following the single injection of estradiol. Leukocytes are decreased to the same levels in both the estrogen-treated and control irradiated animals, although maximal depression and recovery occur earlier in the former. The more rapid recovery of leukocytes in irradiated mice which received a prior injection of estrogen resides in the heterophil component. The anemia of radiation is also less severe in the estrogen-treated animals. Significantly, the maximal estrogen protective effect is observed when mice are irradiated during their leukopenic period. That there is some correlation between heterophil response and lethal effect is indicated in the finding that a rapid recovery of heterophils but not of lymphocytes occurs in mice treated with estradiol 10 days before x-irradiation.

1822 The effects of nitrogen mustard on induced erythroblastic hyperplasia in rabbits. Leon O. Jacobson, Edna K. Marks, Evelyn Gaston, and Matthew H. Block. AECU-528(UAC-101), May 19, 1949. 26p.

The effect of intravenous administration of a nitrogen mustard (methyl bis-β-chloroethyl amine hydrochloride) in a dose of 3 mg/kg was studied in normal rabbits and in rabbits with an anemia and erythroblastic hyperplasia produced by phenylhydrazine hydrochloride. Controls consisted of normal untreated rabbits and rabbits given phenylhydrazine alone. Histopathologic studies were made of animals from each group which were sacrificed at frequent intervals. Hematologic observations were likewise made at frequent intervals. A single intravenous injection of the nitrogen mustard produced only a modest anemia of questionable significance in normal rabbits which was maximal at approximately three weeks. Leukopenia and a marked reduction in the number of circulating reticulocytes were also produced. A rapid destruction of hematopoietic tissue in the spleen, thymus, lymph nodes, and bone marrow occurred within 24 hours. The virtual absence of mitosis during the first 24 hours after the injection of the nitrogen mustard was striking; in stages up to the fifth day mitosis were only rarely seen. During the second, third, and fourth days after nitrogen mustard administration the bone marrow was practically devoid of cells. Only a few scattered hemocytoblasts, erythroblasts, plasma cells, and giant myclocytes were seen. Erythrocytopoietic, granulopoietic, and megakarcyocytopoietic recovery in the group occurred more or less simultaneously. Evidence of regeneration which was first apparent on the fifth day progressed to an essentially normal marrow by the tenth day. Lymphatic tissue though severely damaged by the nitrogen mustard was less atrophic than the bone marrow but regeneration was slower and reconstitution was not apparent until after the fourteenth day. The appearance of leukopenia and reticulocytopenia correlated closely with the hematopoietic destruction, atrophy, and eventual reconstitution. The anemia which developed was modest probably because of the rapid reconstitution of erythrocytopoiesis in the marrow.

Phenylhydrazine alone in the dose totaling 40 mg produced an approximate 50% reduction in erythrocyte and hemoglobin values with a simultaneous reticulocytosis and erythroblastic hyperplasia in the bone marrow. These hematologic values of the peripheral blood returned to normal by 12 days after phenylhydrazine withdrawal but increased erythrocytopoiesis in the marrow persisted for about two weeks. Animals to which 3 mg/kg of the nitrogen mustard was given after an anemia and an erythroblastic hyperplasia of the bone marrow had been produced by phenylhydrazine developed further anemia within the first five days after the nitrogen mustard administration but recovery was complete by the twelfth day. In fact, the hemoglobin and erythrocyte values of this group returned to normal as quickly as in animals which were given phenylhydrazine only. The reticulocyte value of the animals which received phenylhydrazine prior to the nitrogen mustard fell from a value of about 25% to 2% by the third day after nitrogen mustard administration but rose rapidly to 15% by day 3 and slowly fell to normal by about the fourteenth day. The marrow of these animals was extremely hyperplastic at the time at which the nitrogen mustard was given. The usual evidence of destruction followed the nitrogen mustard administration but large numbers of cells in the bone marrow survived as compared to animals which were given nitrogen mustard only. The surviving cells were predominantly basophillic erythroblasts and hemocytoblasts and were present in an appreciably larger number than normally present in controls. Heteroplastic regeneration from reticular cells was conspicuous throughout the first six days after nitrogen mustard administration. Mitosis were present in large numbers even in the early stages after the nitrogen mustard administration and increased rapidly to a

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maximum by about the fourth day. The more mature forms of the erythroblast series were progressively increased in the second, third, fourth, fifth, and sixth day stages after nitrogen mustard administration. A significant recovery of granulopoiesis and megakaryocytopoiesis in the marrow was apparent beginning on the fourth and fifth day after administration of nitrogen mustard in these animals. Hyperplasia in the marrow of these animals continued for about 2 weeks. 10 references.

1823 Influence of the level of adrenal cortical steroids on sensitivity of mice to x-irradiation. R. L. Straube, H. M. Patt, E. B. Tyree, and D. E. Smith. AECU-529(UAC-102), nd. 9p.

The radiosensitivity of intact mice with and without whole adrenal cortical extract or desoxycorticosterone has been determined. Data on the sensitivity of adrenalectomized mice which were obtained as part of another study have been included for comparison. From these data it is concluded that the survival of x-irradiated mice appears to be independent, at least within certain limits, of the amount of adrenal cortical steroids present. The adrenals are apparently involved only secondarily as part of the organism's buffer response to the stress of irradiation. The rationale of employing adrenal corticoids to alter radiation mortality is therefore open to question.

1824 Acquired radioresistance of the crypt epithelium of the duodenum. Margaret A. Bloom. AECU-531(UAC-106), nd. 28p.

Repeated total-body exposures of mice to 60 r x-radiation per day resulted in a lessened sensitivity of the crypt epithelium of the duodenum. Debris in these cells 3 hours after the last irradiation passed on successive days through a maximum and then diminished despite continued treatment. An attempt has been made to measure the degree of this acquired radioresistance in terms of decrease in debris and persistence of mitosis. The duodenal crypt cells showed mild damage after 60 r per day, reaching a peak in mice autopsied 3 hours after 6 to 9 daily exposures. Recovery was complete in mice autopsied 24 hours after the final irradiation. With continued treatment (10 or more exposures) these cells became resistant to this daily dosage (as indicated by negligible amounts of debris and persistence of mitotic activity), even when the total dosage had accumulated to 2100 r. Mitosis was not interrupted and was rarely diminished in this series of low-dosage repeated irradiations. This acquired radioresistance was not sufficient to prevent degeneration of the basal crypt cells or a cessation of mitosis when 600 r or 1200 r was given subsequently in a single dosage. When the single dosage following the daily exposures was 200 r, and an interval of only 1 day or 1 week intervened, there was partial protection against the 200 r exposure: the amount of debris was not diminished, but there were many more mitosis in the crypt cells of mice which has been previously irradiated than in those which had not. The enhanced radioresistance present at 1 day and 1 week was lost when the interval between the termination of the small daily dosages and the 200 r dosage was extended to 2 or 4 weeks. 17 references.

1825 The effect of spleen protection on mortality following x-irradiation. Leon O. Jacobson, Edna K. Marks, Melba Robson, and Raymond E. Zirkle. AECU-535(UAC-111), nd. 5p.

Survival data on groups of mice exposed to single dosages of 600, 700, 900, 975, 1050, and 1200 r total-body x-radiation (250 kv) with or without lead protection of the surgically mobilized spleen are presented in this paper. These data show that the LD_{50} for total-body x-irradiation, exclusive of the lead protected spleen, is nearly twice as great as the LD_{50} for total-body x-irradiation inclusive of the spleen. The mechanism whereby lead protection of the spleen so significantly increases survival from irradiation is yet to be determined.

1826 The effect of x-radiation on the metabolic processes of the resting cell. Theodore N. Tahmisian. AECU-539(UAC-128), nd. 24p.

It is reported that x-radiation dosages ranging from 10,000 r to 200,000 r do not completely inhibit respiration in the diapause grasshopper embryo (Melanoplus differentialis). Respiratory, morphological, and cytological studies revealed that anabolic enzymes are associated with the nuclear material and are more susceptible to x-irradiation damage than the catabolic enzymes. In a resting cell a nucleus was necessary for maintenance of the status quo of the cell. Following x-irradiation a resting nucleus was found not to have to undergo mitosis to become pycnotic. Pycnosis of the resting nucleus depended upon the x-ray dosage, upon the state of metabolism, and upon time. Repression of irradiation damage to the cell was obtained by subjecting the cells to submetabolic temperatures. The integrity of the nuclear chromatin material was dependent upon its functional potency. 19 references.

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1827 The influence of energy absorption and electron range on dosage in irradiated bone. F. W. Spiers. *Brit. J. Radiology 22*, 521-33(1949) Sept.

The problem of dosage in bone, irradiated with x and γ rays, was studied in terms of the ionization received by the soft tissues enclosed in the Haversian systems. The physical radiation dose, in ion pairs per cubic micron per roentgen, was arrived at by calculations of the electron emission of bone in relation to the size of the cavity irradiated; the dose was shown to depend on both cavity size and wavelength of the radiation used. The calculations were in accord with the relevant available experimental observations and their significance is discussed in relation to clinical experience. The results of the calculations suggested that, for the commonly used 200-250 kv x-radiation, the tolerance dose of the soft tissue elements in bone may be only one half of that of soft tissues in other situations; for medium voltage and superficial x-rays this relative tolerance may be no more than one-third; only for short wavelengths, generated at about 1 Mev, does the ionization in the living elements in bone approach that in other soft tissues. 19 references.

1828 Mechanism of induction of ovarian tumors by x-rays. Louis Lick, Arthur Kirschbaum and Harry Mixer. *Cancer Research 9*, 532-6(1949) Sept.

The results of experiments to determine whether x-rays induce tumors in mice in the presence of normal ovarian function are discussed. The Bagg albino stock of mice was used. The ovaries were irradiated with a Phillips Contact Therapy Machine at 45 kv through 1 mm Al filtration at a 19 mm target distance and at a rate of 1,500 r per min. Practically all the females receiving 200 r whole body irradiation at 8-10 weeks of age developed bilateral ovarian tumors if they survived 16 months after the irradiation; mice receiving 200 r irradiation to one ovary after the extirpation of the other ovary demonstrated 100% tumor development; mice receiving 200 r locally to one ovary with the other protected and intact developed no tumors in the irradiated ovary. However, a granulosa cell tumor did develop spontaneously in a non-irradiated ovary. Larger doses of x-radiation produced results similar to the 200 r irradiation. 14 references.

1829 The response of tissue to total body irradiation. John L. Tullis. *Am. J. Path. 25*, 829-52(1949) Sept. (See also NSA 2-36)

Two series of experiments involving whole body irradiation of swine are described and the results are discussed. The results of the Bikini atomic bomb experiments were found to be similar to experiments performed separately at the Naval Medical Research Institute (experiments which consisted of irradiating swine from a 100 kv source with no filtration, at a distance of 1 m with whole body x-radiations and at a rate of 30 r); in the latter experiments the 50% lethal dose/30 day period was found to be 275 r measured in air. The lesions produced in both series were characterized by hemorrhage, necrosis and secondary infections; lymphoid cells, myeloblasts, germ cells and intestinal epithelium were found to be particularly radiosensitive, injury to these cells causing anemia and lowering of resistence to infection. Irradiation caused a dilitation of capillaries, and impairment of circulation and tissue anoxia; the pathological state was self-perpetuating. It is concluded that since the most primitive hematopoietic stem cells, the reticular cells, are relatively radio-resistent, the effort to reduce mortality does not appear to be hopeless; management of the effects of total body irradiation should be directed at the prevention of secondary infections, such as pneumonia, which often occur when the organism is in a weakened condition, and the treatment of anemia, impaired circulation and anoxia.

1830 Studies on the mechanism of action of ionizing radiations. V. The effect of hydrogen peroxide and of x-ray irradiated sea water on the respiration of sea urchin sperm and eggs. E. S. Guzman Barron, Veronica Flood and Betty Gasvoda. *Biol. Bull. 97*, 51-5(1949) Aug. (See also NSA 2-2079; 3-957; 3-1514)

The results of experiments on the sea urchin sperm respiration rate after the addition of hydrogen peroxide to the medium and after x-irradiation of the medium are presented. The hydrogen peroxide was used at concentrations of 0.01-0.0001 M in a 1:200 sperm solution; x-ray dosages of 50,000-200,000 r were given. Total inhibition by hydrogen peroxide occurred at 0.001 M concentration; the inhibition decreased with peroxide concentration and approached zero at 0.0005 M. When sea water was irradiated with 200,000 r, a 60% sperm inhibition occurred; 50,000 r produced a 10% inhibition, while the addition of catalase, previous to the sperm addition and after irradiation, had no effect on the inhibition. Since the sea water irradiated with 200,000 r gave no positive test for hydrogen peroxide it is postulated that inhibition is not due to the action of H_2O_2 but to stable organic peroxides.

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1831 Study of the revivesence of the thymus. V. Thymal-adrenal relationships. The action of adrenaline on the revivescence of the irradiated thymus. Luigi Viale and Cesare Ravazzoni. *Arch. "E. Maragliano" Patologia Clinica 3*, 1171-80(1948) Sept.-Oct. (In Italian)

Studies determining the effects of adrenaline on the rate of renewal of the vital activities of the thymus gland after irradiation are presented. Male and female guinea pigs, weighing an average of 172 g, were irradiated separately with a dose of 85 r directed at the thymus gland; ten days after the irradiation, adrenaline treatments were initiated with daily doses of 0.25 mg; the treatments were continued for 10 consecutive days, and after a lapse of 20 days, the animals were sacrificed. It was found that the adrenaline administered to the animals stimulated a revivescence process; vasal changes were noted histologically. It was concluded that the revivescence process for the thymus is remarkably enhanced by the administration of the adrenaline, even if to a somewhat variable degree. 27 references.

1832 Study of the revivescence of the thymus. VI. Thymus-thyroidal relationships. The action of thyroxin on the process of the revivescence in the irradiated thymus. Luigi Viale and Cesare Ravazzoni. *Arch. "E. Maragliano" Patologia Clinica 3*, 1181-94 (1948) Sept.-Oct. (In Italian)

The action of thyroxin on the revivescence process in the irradiated thymus of the guinea pig was studied in order to determine the thyroid-thymus relationship and the influence of hormones on the revivescence process. Experiments were conducted on two series of animals of both sexes, a group receiving thyroxin therapy and a control group; each group contained 10 animals and was irradiated by means of plesio-therapy with 85 r to the thymus gland after the surrounding tissue had been protected with a lead barrier. The therapy group received thyroxine from the tenth through the twentieth day after the irradiation, and both groups were sacrificed on the thirtieth day following irradiation. The average body weights of the two groups were compared and it was found that the control group outgained the experimental group by 61 g (107 to 46 g). The thymus glands in both groups were excised and examined; positive body balance was demonstrated in both groups. The results indicated that the revivescence process occurred in a similar manner in the groups and produced similar results. The significance of the difference in body weight between the groups is discussed. 66 references.

1833 Thyroid destruction by I^{131}, and replacement therapy. C. F. Winchester, C. L. Comar, and George K. Davis. *Science 110*, 302-4(1949) Sept. 23. (See also NSA 2-41)

This report presents a method by which thyroids of young chickens were eliminated by I^{131} irradiation; no other damage to the animals resulted except partial destruction of the parathyroids in some cases. The animals, New Hampshire chicks, were only a few days old at the time of treatment and were brought to full size and egg production thereafter through the administration of thyroxin. The I^{131} therapy consisted of intraperitoneal injection of 1-9.2 mc/100 g body weight over a period of 5-24+ days; this was followed by intradermal injections of synthetic d,l-thyroxin in water suspension into the wing areas. The results of the experiments show that doses of 6 mc or more of activity per 100 g body weight over periods of 24 days accomplished the complete destruction of the thyroid. The injected chicks with destroyed thyroids grew more slowly than normal and survived only a limited time after injection (7-18 weeks) unless they were given the thyroxin therapy; the first visible response to the thyroxin injections was the rapid resumption of growth and feather development. The ionizing effects of the radio-iodine on the reproductive organs were closely observed; it was noted that in two of the three females, allowed to grow to egg laying age and having received thyroxin therapy, ovulations were normal and egg production was comparable to normal standards; a third female that had received 9.2 mc/100 g body weight was found on autopsy to have developed normally, and presumably would have begun egg production in a short time.

1834 Potential hazards and pathological aspects of radioactive isotopes. Hermann Lisco. AECU-521(UAC-86), nd. 7p.

It is pointed out that health and safety programs have made it possible for people to handle kilograms of radioactive materials and to deal with sources of high energy radiations of various types without harm, in the vast majority of cases. Unknown factors still to be dealt with are mentioned as the nature and the mechanisms of the biological action of radiations in general and of radioisotopes in particular. Criteria that are being used to formulate and establish the laws and

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principles of toxicology as applied to radioactive isotopes are indicated. Some common pathological denominators are noted as for instance: the incidence of blood dyscasias, abnormalities of the liver, neoplasms of bone, lung, and skin, and graying and loss of hair. The isotopes that have been studied have generally shown a distribution that included the skeletal system, the liver, and the blood-forming organs. Two aspects of potential hazards are given: proper handling of radioactive isotopes and care and judgment in applying radioactive isotopes in the diagnosis and treatment of disease.

1835 Biological hazards and toxicity of radioactive isotopes. Austin M. Brues, Hermann Lisco, and Miriam P. Finkel. AECU-525(UAC-93), nd. 24p.

The effects of large dosages of radioisotopes are said to resemble to a marked extent those of total-body radiation, with modifications dependent on tissue distribution. Permissible exposure levels are determined by the late or chronic radiation changes, of which malignant changes have quite properly attracted major attention. There is no evidence to indicate that radiation dosages to tissue corresponding to established "permissible" external dosages (0.3 - 0.6 rep/week) will result in an increased incidence of malignant disease detectable in a population of moderate size. In making such calculations, it is necessary to estimate maximum local tissue dosage, rather than the mean value for an organ or structure, and to make use of factors recognizing the greater effectiveness of ionization in areas where it is dense (e.g., alpha-particle ionization). The suggestion is made that a more conservative figure is desirable where a large population may be affected; and the basis for using larger dosages in clinical investigation, diagnosis, and therapy is discussed. Bone tumor induction by Sr^{89} has been studied extensively in mice. The data are consistent with the view that each given quantity of radiation to bone confers a given probability of bone tumor formation which may occur at any time following a "latent period". The latent period increases gradually with the dosage. It is not known at present whether a threshold exists for such effects. 32 references.

1836 General rules and procedures concerning radioactive hazards. Isotopes Branch Circular ID-B-1 (Revised), Aug., 1947. 15p.

This compilation from "Standard safety requirements" (AEC safety regulation No. 3) covers the following: tolerance (maximum permissible exposure); radiation monitoring; protective clothing and devices; eating and smoking rules; contamination of personnel; contamination of areas; the storage, handling, and disposal of radioactive materials; summary of responsibilities for the enforcement of radiation rules. The following appendixes are included: A. Definition of radiation terms; B. Personnel monitoring meters; C. Surgical technique for putting on and removing rubber gloves; D. Recommended procedure for washing and decontamination of hands.

1837 Insurability of atomic energy workers. H. M. Parker. General Electric Company, 1948. 18p.

The purpose of this pamphlet is to describe the facts concerning life expectancy of Atomic Energy workers in the light of the best present knowledge, to discuss the estimated validity of such knowledge, to remove hysteria on the one hand, and to suggest legitimate areas of safeguards for insurance writers on the other. The damaging effects of ionizing radiation are stated in the subdivisions on acute exposure and chronic exposure, with special reference to possible effects on the life span of the individual. Estimates of the shortening of life are applied to the Hanford Works operating experience. The known operating risks for the future are indicated. Compensating increase of life span, compared with such occupations as normal chemical manufacture or radiation therapy, is expected to arise from the extensive medical and industrial safety controls applied in the field of atomic energy. The validity of present day permissible exposure limits is discussed. Legitimate safeguards for those proposing to write insurance without extra premium are proposed.

1838 Clinic of the atomic bomb radiation sickness. Kanshi Sassa. Tokyo Imperial University, nd. 30p. (NP-303).

This is a summarized report on the clinical observations of radiation sickness caused by the atomic bomb explosions in Hiroshima and Nagasaki. Over 10,000 patients were examined. Mechanically caused or heat injuries such as wounds and burns are not included. The etiological factors considered are age, sex, distance from center of explosion, and shelter. General symptoms such as fever and fatigue are described. Observations on the digestive, respiratory, and sex organs, the nervous system, the oral cavity, eyes, skin, blood and urine of victims of radiation sickness are discussed.

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1839 Pathology of atomic bomb casualties. Averill A. Liebow, Shields Warren and Elbert DeCoursey. *Am. J. Path. 25*, 853-1028(1949) Sept.

A description is presented of the effects of the atomic explosions at Nagasaki and Hiroshima; the human injuries were mechanical, thermal, and ionizing in nature. Direct blast injuries analogous to those inflicted by high explosives were almost unknown among the survivors; however, damage produced by shattered glass and the like accounted for a high toll of injury. The burns among the survivors were mostly of the flash type, the result of an extremely large quantity of radiant heat acting for an extremely short period of time, and were characterized by sharply outlined areas; the effects of exposure extended up to 4,000 yards from the bomb. Depigmentation occurred in an area close to the bomb, but intense pigmentation occurred at larger distances from the explosion; the depigmentation occurred without destruction of the squamous epithelial skin surface, and was probably the result of the action of certain specific wavelengths. The radiation effects consisted of early symptoms of nausea and vomiting followed by diarrhea and fever, and developing into complications such as aplastic anemia, leukopenia, and secondary infections such as pneumonitis or ulcerative enteritis. At necropsy, changes were found in the skin, gastro-intestinal tract, gonads, and hematopoietic tissues. The specific radiation effects on these areas are described in detail. The remarkable resistence of the reticulum cell and the tendency of the bone marrow ultimately to regenerate are emphasized, and it is hoped that these phenomena indicate that successful defense measures against the radiations will be devised. Further studies are still in progress to investigate the relationship between life span and irradiation, the incidence of neoplasia among survivors, and the radiation effects on growth, sterility, and genetic mutation. 98 references, 143 plates.

1840 Radiodermatitis and necrosis. Thomas D. Cronin and Raymond O. Brauer. *Surgery 26*, 665-72(1949) Oct.

A description is presented concerning the pathology and treatment of radiation necrosis and dermatitis. The pathology in chronic radiodermatitis consists of hypertrophy of the epithelium and atrophy of the corium, with the loss of the sebaceous glands, hair follicles and sweat glands; there is a marked obliterative endarteritis affecting all vessels and seriously reducing the blood supply to the area. Pain is the outstanding feature of all deep burns, and usually does not appear until a late stage. Therapy usually consists of the removal of the diseased area by electrodessication and coagulation, by excision, or by amputation. Occasionally palliative treatment is deemed advisable and consists of the application of moist dressings of saline or boric solutions, soothing ointments or fresh leaves of the Aloe vera plant; the palliative therapy is particularly indicated for the symptomatic relief of early or mild radio-dermatitis, in cases of acute ulceration, and where surgery is refused. The various techniques of skin grafting to replace the damaged areas are briefly outlined, and it is noted that a pedicle graft carrying its own blood supply must be used in all cases where the radiation damage extends to the deeper areas and structures. 12 references.

1841 What you should know about the atomic bomb. A message from the surgeon general. R. W. Bliss. Army Medical Department, nd. 50p.

This pamphlet contains the following series of articles based on lectures delivered during a course in atomic medicine sponsored by the Armed Forces Special Weapons Project: I. Introduction to nuclear physics; II. Biologic effects of nuclear radiation from an atomic explosion; III. Medical effects of atomic explosion; IV. Evaluation of the five atomic explosions; V. Fundamentals of radiation pathology; VI. Pathologic anatomy of radiation effects of atomic explosion; VII. Detection of overexposure to ionizing radiation; VIII. Public health aspects of atomic explosion; IX. Essentials of instrumentation; X. Protection against atomic bombs.

1842 Biological studies with arsenic^{76}. III. The effect of arsenic ^{76} upon the clinical course of patients with tumors of the hematopoietic tissues. Matthew Block, Leon O. Jacobson, and William Neal. AECU-533(UAC-108), nd. 25p.

Twenty-four patients with tumors of the hematopoietic tissues, 2 with polycythemia rubra vera, and 1 with metastatic carcinomas have been treated with intravenous injections of radioarsenic (As^{76}). Since both arsenic and irradiation have been used independently in the treatment of tumors of the hematopoietic tissues it was thought that it might be advantageous to utilize radioarsenic (As^{76}), a substance that is metabolized like stable arsenic, exerts a similar chemotherapeutic effect, and is, at the same time, a source of radiation. In this way it

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might be possible to benefit the patient by simultaneous chemotherapy and radiation therapy. Results are described in each case. Considering various uncontrolled factors such as previous therapy, duration of the disease, supplemental therapy, rest, psychic factors, etc., this radioisotope appeared to offer no advantages over the types of therapy already in use for these conditions. 27 references.

1843 Basal pigmented epithelioma. N. Puente Duany. *Arch. cuban. cancerol.* 7, 287-336 (1948) Oct.-Dec. (In Spanish)

The etiology, clinical diagnosis and the treatment of pigmented basal epithelioma are presented. The therapeutic methods available for the treatment of the disease were surgery, electrosurgery, and irradiation; the irradiation technique consisted of a 200-kv source at 50 cm distance delivering radiations through a combined 0.5 mm Cu and 1.0 mm Al filter to a field of about 16 cm^2. A total dose of 2,400 r was usually delivered in single sessions of 300 r for eight consecutive days; the tumors usually disappeared within two weeks after the end of the therapy. It is observed by the author that not nearly as radical a procedure is needed for the adequate treatment of this type of lesion as for malignant melanomas. 79 references.

1844 Cancer of the breast. Robert McWhirter. *Am. J. Roentgenol. Radium Therapy 62,* 335-40 (1949) Sept.

A roentgen ray method of treatment of cancer of the breast is described and the results of this method and surgery are presented. The post-operative radiation technique in the cases treated was one full course of therapy with the delivery of about 3,750 r over a period of three weeks; this treatment was usually begun about two weeks after the operation and the radiations were delivered by a 250-kv source to four fields with every field being treated once a day. The five-year survival rate of all cases during the period of 1941-1942 was 41%.

1845 Cancer manual. The cancer committee of the Iowa State Medical Society. Iowa City, Iowa, Athens Press. 1948. 160p.

The etiology, diagnosis, prognosis, and treatment of various types of carcinoma are discussed in separate chapters; radiation therapy is indicated as the treatment of choice for some of these conditions. The roles of x-ray and radium therapy are summarized in a short discussion. Few specific doses are mentioned for the treatment of the conditions described.

1846 III. Cancer of the vulva treated by radiation. An analysis of 127 cases. Frank Ellis. *Brit. J. Radiology 22,* 513-20(1949) Sept.

A report is presented on 127 cases of carcinoma of the vulva treated at the Sheffield Radium Center from 1941 to 1943. The therapy was radium, x-rays, and surgery, singly or in combinations. Ninety-two of the cases were squamous carcinomas, 3 were adenocarcinomas, 1 was malignant melanoma, 1 was fibrosarcoma, and 30 were unspecified. The maximum tissue dosage given in the radium cases was 6,000 r in 5 - 7 days; the x-ray therapy to the vulva was given by deep x-rays, using a direct field or a combined wedge field and direct field, and a total dose of 5,000-6,000 r for the cases treated solely by this method (1,000 r was administered before operation in the combined surgery and x-ray method). The 5 year survival rate for the cases treated by the radium method was 23-32%, and the 10-year rate was 8-11%; the survival figures for the surgery technique were similar; x-radiation therapy yielded a 27% survival rate. Necrosis, when it occurred, followed radium therapy of the posterior half of the vulva more often than the anterior half.

1847 Carcinoma of the vulva. I. The treatment of cancer of the vulva. Elis G. E. Berven. *Brit. J. Radiology 22,* 498-507(1949) Sept.

The technique and methods of application of electro-coagulation and teleradium therapy are described and the results of the treatment of carcinoma of the vulva with these methods are presented. The cases were classified into three stages: Stage I consisted of cases where no clinical metastases could be demonstrated on admission; in Stage II cases, well defined, well operable clinical metastases could be demonstrated; and in Stage III cases the metastases were inoperable, fixed, or disintegrated. One week after electro-coagulation, teleradium treatments were given to patients in each of the three groups defined. The teleradium treatments for Stage I consisted of 2,700-3,600 r delivered to each of two groin regions; an erythemic epidermitis was seen soon afterwards. Stage II cases received the same type of treatment; but Stage III

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cases received groin therapy up to 4,500 r; surgery was occasionally resorted to. The radiological method alone yielded a 5-year cure rate of about 12%. The combined electro-coagulation and teleradium method gave a cure rate of over 25%. 15 references.

1848 Clinical radiation therapy. Ira I. Kaplan. New York, Paul B. Hoeber, Inc., 1949. 844p.

This book comprises a comprehensive presentation of various phases of radiation therapy; the historical development of the various types of treatment and indications for their use are outlined. The effects of the irradiation in ear, nose, and throat conditions, skin conditions, chest conditions, inflammatory conditions, breast conditions, gastro-intestinal conditions, and gynecologic, genito-urinary, bone, and neurologic conditions are described in separate chapters. The treatment of specific diseases of the reticulo-endothelial, blood, and lymph systems are also discussed; and the applications of radiation therapy to the field of endocrinology are outlined; dosages are included. Complications and injuries associated with x-ray and radium therapy, and the legal aspects concurrent with the conditions under discussion are described in detail. A bibliography accompanies each chapter and graphs and pictures are included which trace the course of the diseases treated. 614 illustrations.

1849 Contribution to the study of contact radiotherapy. Jean De Backer (Gand). *Radiologia Clin. 18*, 235-9(1949) July (in French)

A brief resume of contact radiotherapy in the treatment of various types of malignancies is presented. The authors use the Philips apparatus, of which the principle characteristics are: 50 kv; 2 mA; focal distance, 18 mm; filtration through 0.2 mm Al, with supplementary filters which can be attached to the tubes, of 1 mm and 2.5 mm Al. In the treatment of malignant tumors a dose of 3,000 - 4,000 r in one treatment gives excellent results in cases of very small superficial tumors. In a comparative study of the methods used by the authors they point out the danger of using excessive doses in various single exposures. Recurrences are frequent, slow radionecrosis is not rare, and scarring is often extremely unsightly, atrophic, and telangiectatic. 25.5% of the patients relapsed when treated by a single dose of 3,300 - 10,000 r, administered without a filter and with the tube in contact with the lesion; only 5.3% suffered recurrences from the cases treated by fractional doses. Nevocancers (cancers developing on moles) are preferably treated by electro-coagulation; angiomas, certain types of cheloids, and warts are treated by contact therapy. In angioma the indicated dose is 300 - 400 r, according to the age of the child, for the non-ulcerative angiomas having a tendency for ulceration. The second irradiation is administered 3 - 4 weeks after the first, the third, 6 - 8 weeks after the second. If, after 3 treatments the angioma is not healed, the treatment cycle is repeated at intervals of 3 and 5 months. Cheloids are treated by doses of 400 r with a radiation filter of 1 mm Al, and repeated at several day intervals with good results. Most warts disappear after a single treatment with contact radiotherapy of 3,000 - 5,000 r, according to the dimensions of the warts. 17 references.

1850 An evaluation of radium treatment to the nasopharynx in asthmatic children. Victor L. Cohen and Wilbur J. Fisher. *J. Allergy 20*, 328-34(1949) Sept.

A method of evaluating the severity of asthma in children is presented and the results of the treatment of a number of cases with radium applications are described. The radium treatment consisted of a 6.5 min exposure to 100 mg of radium contained in a Crowe applicator and applied to the nasopharynx; four treatments were given at intervals of 3 weeks. Improvement in asthmatic symptoms occurred for about 17 weeks following the radium treatment, with those patients who exhibited high sedimentation rates before treatment responding more satisfactorily than those with normal rates; patients with normal sinuses or a small amount of adenoid tissue also demonstrated better relief from symptoms than those with either hyperplastic sinusitus or large quantities of adenoid tissue. It is concluded that the radiation method should be used as an auxiliary in the treatment of asthma.

1851 Malignant disease of the mouth. S. H. Wass. *Guy's Hosp. Gazette 63*, 260-5(1949) Aug. 27.

The pathological and clinical features, diagnosis, prognosis, and the principles of treatment of malignant diseases of the mouth are discussed. The three methods most commonly used in the treatment of the diseases were interstitial radiation by means of radium needles or radon seeds, surface application of radium needles on a suitable intraoral applicator, or distant radiation therapy with deep x-rays or teleradium; the location of the lesion determined the method

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to be used. The total dosage was usually of the order of 5,000-10,000 r; surgery was occasionally used, especially in cases of lesions involving the bone structure. The 5-year survival rates for the various regions of the mouth (tongue, lip, palate, tonsil, floor of mouth, inside of cheek, alveolus) varied from 5-60%.

1852 A new technic for the radium treatment of carcinoma of the bladder. Milton Friedman and Lloyd G. Lewis. *Radiology 53*, 342-62(1949) Sept.

The Walter Reed General Hospital technique of iso-irradiation of the lower two-thirds of the bladder wall with fractionated doses of penetrating γ rays from a focal source of radium, radon, or radioactive cobalt fixed at the center of the bladder cavity is presented and described in detail. Thirteen cases were favorably treated with this method. A radium dosage of 5,000-9,000 r was usually administered with 25 mg radium capsules in two sessions over a total period of 10-12 days, with a 3-4 day rest between the first and second session; the interruption of the treatment was found to reduce bladder irritation and the intensity of the later reaction of the mucosa. The results of a biopsy and a measurement of the clinical shrinkage resulting from the first dose determined the dosage delivered at the second session. Twelve of the first thirteen patients treated are free of disease after 10-48 months.

1853 Ocular lymphomas. Parker Heath. *Am. J. Ophthalmology 32*, 1213-23(1949) Sept.

Sixty-seven cases of ocular lymphoma are presented in this series and the methods of treatment, surgical extirpation and irradiation, are described. The three most frequent tumor sites in these cases were the conjunctiva, the orbit, and the lid; the conjuctival cases are discussed fully here. The radiation procedure consisted of irradiation with a 200-kv source, at a 20-cm target distance, through a 0.25-mm Cu filter; daily doses for the conjunctival cases were usually 200-300 r directed into the conjunctiva for a total of 600-900 r; this has not resulted in any untoward effect on the eye, immediate or remote (except in one case). The results of this type of therapy, alone or in combination with surgical extirpation, demonstrate an extension of the life span with or without recurrence of the disease, depending on its initial type, site, and degree of involvment. 14 references.

1854 Pre-operative radiotherapy in the treatment of osteogenic sarcoma: a preliminary communication. R. Kaye Scott. *Med. J. Australia 2*, 304-5(1949) Aug. 27.

The results from a low-dosage, prolonged type of x-radiation in the treatment of osteogenic sarcoma are described. The daily doses usually consisted of 100-150 r of hard quality radiations; they were delivered 5-6 times a week until a tumor dose of 4,500 r was reached; after a ten-weeks rest, the treatment was repeated, frequently in successive series at slightly lower dosage levels. Local response to x-ray therapy was obtained without subsequent development of metastases within 14-18 months in eight cases; in a total of 18 cases, 13 resulted in temporary control of the tumor. It is noted that x-ray therapy is best used pre-operatively and should be followed by amputation surgery within about 18 months; the presence of any secondary deposits of sarcoma may be determined in the interval between surgery and irradiation.

1855 II. Radium implantation treatment of carcinoma vulva. Margaret C. Tod. *Brit. J. Radiology 22*, 508-12(1949) Sept.

The radium treatment of cases of carcinoma of the vulva is presented and consists of the implantation of radium needles in the vulva area and the distribution of total doses of 5,500-6,000 r over periods of seven days. The results of this type of treatment show that the 5-year survival rate of the cases treated early was 33% and with late cases, 14%; the total survival rate was 25%. The author concludes that with late cases involving the lymph nodes, block dissection gives much more favorable results.

1856 A review of the uses of radioactive iodine with a note on preliminary work in Melbourne. R. Kaye Scott. *Med. J. Australia 2*, 273-6(1949) Aug. 20.

A review is presented on the basic features of radioiodine tracer tests and the diagnostic and therapeutic doses. The absorption and the fate of administered iodine are discussed and data on the specific uptake of the isotope by thyroids in normal subjects and subjects with myxedema, cretinism, hyperthyroidism, Graves's disease, and colloid adenoma are presented. The unknown dangers of total body irradiation from sources such as tracers are emphasized; the possibility of genetic mutation through the administration of tracer doses is stressed. Work at present being done in Melbourne, Australia, involving the use of radioiodine is outlined; a

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device for controlling and measuring the radiations is described, consisting of a collar cast with vials containing radio-iodine held in a position lateral to the lobes of the thyroid gland. The radioiodine was used as a diagnostic means in cases of suspected thyrotoxicosis, but in all but one case of carcinoma with enlarged cervical glands it failed to demonstrate deposition within the known metastases. Further work is in progress. 11 references.

1857 Roentgen and radium treatment. Paul Hess. Berlin-München, Urban, and Schwarzenberg 1948. 140p.

This book covers the physical and biological principles of radiation therapy, and the recommended doses for therapeutic use in dermatology and other fields. The radiation techniques and methods which are applicable to patients in poor and good general conditions are outlined. A comprehensive discussion of the field of radiology is presented.

1858 Roentgen therapy as the sole method of treatment of cancer of the breast. F. Baclesse. *Am. J. Roentgenol. Radium Therapy 62*, 311-19(1949) Sept. (See also NSA 3-249).

The results of the treatment of 130 cases of carcinoma of the breast with x-irradiation are presented. The technique consisted of radiations from a 180-kv source through a filter of 1 mm of Cu at a target distance of 60 cm and an intensity of 20 r/min. The average number of fields used was six or seven, varying in size from 100-150 cm^2. The irradiation was applied so as to provide an interval of 2-3 days between successive treatments to any one field; the fractionation was usually extended to about 3-4 months, and was increased with increasing total doses. Individual doses per field usually were 200-250 r, and in exceptional cases 300 r/field; two fields were treated daily, and sometimes three. Total tumor doses were 4,100-9,000 r and it was noted that only with total doses of 5,000 r or more was there a clinical disappearance of the tumor. Complications involving injury to the skin, subcutaneous tissues, muscles and nerves, bones, lungs and heart were ascribed to errors such as too high doses, too large fields (overlapping and faulty direction of the radiation beam. The 3-year survival rate for 130 cases was 31%, for all stages of the disease.

1859 A statistical study of cancer of the corpus uteri. J. P. Palmer, M. C. Reinhard, M. G. Sadugor, and H. L. Goltz. *Am. J. Obstet. Gynecol. 58*, 457-67(1949) Sept.

The results of the treatment of 957 cases of cancer of the corpus uteri are presented; and the influence of such factors as marital status, weight, nationality, diabetes, hypertension, age, menarche, and menopause on the course of the disease are discussed. The cases were treated with a variety of techniques; the more recent cases received higher doses (3,000-5,000 r) into the uterine area which were delivered by high kv machines and heavy intracavitary implants. The cases are grouped according to stages, and the dosage and method of treatment for each is described. There was a 5-year absolute cure rate of 32.1% for all of the cases treated; the cure rate progressed from 25.0% in 1920 to 39.3% in 1942. It was shown that total hysterectomy and bilateral salpingo-oophorectomy following pre-operative irradiation produced the best cure rate. 22 references.

1860 Transactions of the American Goiter Association - 1948. Springfield, Illinois. Charles C. Thomas, Publ., 1949. 260p.

Among the papers presented at the 1948 Annual Session of the American Goiter Association, held in Toronto, Canada were the following: Radioactive iodocasein: its action, fate and distribution in the human, C. F. Hamilton; Tracing the thyroid hormone in peripheral tissues, William T. Salter and MacAllister W. Johnston; The behavior of radioiodine in the blood in various thyroid states, William M. McConahey, F. Raymond Keating, Jr., and Marschelle H. Power; Dosimetric and protective considerations for radioactive iodine, James J. Nickson; The biologic effect of irradiation by radioactive iodine, Bengt N. Skanse; Graves' disease: treatment with radioiodine (I^{131}), Mayo H. Soley, Earl R. Miller, and Nadine Foreman; The use of radioiodine in the treatment of exophthalmic goiter, Samuel F. Haines, F. Raymond Keating, Jr., Marschelle H. Power, Marvin M. D. Williams, and Mavis P. Kelsey; The collection of radioactive iodine by the human fetal thyroid, Earle M. Chapman, G. W. Corner, Jr., David Robinson, and R. D. Evans; A study of the histopathology and physiologic function of thyroid tumors, using radioactive iodine and radioautography, Brown M. Dobyns and Beatrice Lennon; The effect of total thyroidectomy on the function of metastatic thyroid cancer, Rulon W. Rawson, L. D. Marinelli, Bengt N. Skanse, Jack Trunnell, and Rex G. Fluharty; Certain goiter problems, Ambrose L. Lockwood.

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1861 Treatment and results in cancer of the breast. Elis Berven. *Am. J. Roentgenol. Radium Therapy 62*, 320-5(1949) Sept.

The 5-year survival rates for several large groups of cases of carcinoma of the breast are discussed and the methods of pre-operative and post-operative irradiation by x-rays are described. In pre-operative treatment x-rays are directed to a large anterior field including the breast, axilla, and the supraclavicular fossa; irradiation is also directed through a posterior field in an area encompassing the axilla and the breast. The modern treatment consists of administering doses of 350 r to each field for a total of five times, the radiations emanating from a 180-kv source through a 0.5 mm Cu filter and at a target distance of 50 cm. The total dose delivered over a period of ten days is usually about 2,000 r, while that given to the axilla is about 1,500 r. If the breast is small, four portals are used, medial, lateral, anterior, and posterior; the surgical operation is performed three weeks after the radiation treatment. The first post-operative treatment begins after the operation wound is healed, and usually consists of irradiation in two fields, posterior and anterior; the anterior field receives 300 r doses for three times using a 102-kv source with a 1 mm Al filter at a target distance of 50 cm. The posterior field receives radiations through 0.5 mm of Cu and 1 mm of Al at dosage levels of 350 r for three times, and at a target distance of 40-50 cm. The post-operative treatment is repeated after two months and again after another three months. This 5 year survival rate is variable, depending on the stage of the disease and other factors, such as the mode of treatment. The results indicate that pre-operative x-radiations greatly improve the prognosis in cases where cancerous growth has begun to invade the axillary tissue. 11 references.

1862 Treatment and results in cancer of the breast. Sir Stanford Cade. *Am. J. Roentgenol. Radium Therapy 62*, 326-7(1949) Sept.

The results of the treatment of 915 cases of cancer of the breast with surgery and radiotherapy are described. The technique of roentgen irradiation consisted of radiations from a 200-220-kv source at a target distance of 40-50 cm with a 2.0 mm Cu or Thoraeus filter. In most cases the radiations were directed to three sides of a triangular space in such a way that maximum uniformity of dosage was achieved; the duration of the treatments was usually 4-5 weeks with an average total dosage of 3,500 r. The role of radium is discussed; the technique used consisted of the administration of low intensity needles intermittently over a period of 3-4 weeks so as to deliver 6,000-9,000 γ r. Radium therapy used exclusively produced a 5-year survival rate of 15-70% depending on the stage of the disease; the combined radium and surgery method yielded a 5-year rate of 10-78%, and surgery showed a rate of 9-87%. Other statistics are also presented.

1863 Urinary excretion of radioactive iodine as a diagnostic test in thyroid disease. D. G. Arnott and E. W. Emery. *Lancet 2*, 460-5(1949) Sept. 10.

The urinary excretion of I^{131} was followed for 48 hr after the administration by mouth of a tracer dose of 10 μc of I^{131} with 10μg of potassium iodide; 30 normal adults, 26 adults with obvious thyrotoxicosis and three adults with obvious hypothyroidism, were studied. There was no evidence of correlation between the urinary excretion of the I^{131} and the patients' sex, age, or weight, or with moderate variations in exercise during the test, or with the volume of urine excreted. Comparison of the three main groups of normal, thyrotoxic, and hypothyroid confirmed previous observations that the rate of fall of urinary excretion-rate of I^{131} gave an indirect index of thyroid activity. A simple and sensitive differentiation could be made between these three groups by measuring the urinary excretion in the four periods 0-8, 8-12, 12-24, and 24-48 hr. Thyrotoxicosis was found to be best characterized by low values in the 8-12 hr period, and hypothyroidism by high values in the 24-48 hr period. Further experience with this test is required, particularly in cases of mild thyrotoxicosis and hypothyroidism, and of renal and circulatory disease.

1864 Urinary excretion of radioactive iodine as a diagnostic aid in thyroid disorders. A. Stuart Mason and R. Oliver. *Lancet 2*, 456-60(1949) Sept. 10.

The present investigation was undertaken to determine the feasibility of using the urinary excretion of I^{131} as a routine diagnostic test for thyroid disease cases. A standard of 10μc of I^{131} per test was adopted and found to be sufficient, since it gave a measurable excretory amount in all cases of thyrotoxicosis; the dose was mixed into 50 ml of distilled water and 5 ml was saved for sampling while 45 ml was taken orally. The volume of each urine sample was recorded along with the radioactivity of the sample; the collections were made 2,4,6,9,12 and 24 hr after the oral administration. It was found that the measurement of the urinary excretion between the

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6th and 24th hr after administration of the dose provided a reliable diagnostic test for thyrotoxicosis; a urinary excretion of under 4% during this period indicated a definite thyroid activity, and an excretion over 25% indicated myxedema. It is observed that the I^{131} loss in sweat and bile is not likely to be greater than 2-3% of the average dose and will not affect the diagnostic determination. It is therefore, concluded that this method is a valuable means for the determination of cases of thyroid abnormalities.

CHEMISTRY

1865 Exchange reactions between the oxidation states of thallium in perchloric acid solutions. G. Harbottle and R. W. Dodson. AECU-475, nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

The rate of exchange of thallium between thallic and thallous states has been measured in aqueous perchloric acid solutions at various concentrations of acid and of added chloride, ionic strength being maintained constant at 6N with sodium perchlorate. The rate is first order in the total thallic concentration and in the total thallous concentration. In the absence of chloride, the rate decreases with increase in the acid concentration; the results are interpretated in terms of a reaction path involving hydrolyzed thallic ion. To assist in the interpretation, the dependence of the mean activity coefficient of perchloric acid on its concentration has been estimated, and the Hammett acidity function measured. Low chloride concentrations decrease the rate, moderate concentrations accelerate it, over a total range of about a million-fold in the rate. This effect is ascribed to chloride complex formation, evidence for which was also obtained from transference, potentiometric, and spectrophotometric measurements. The catalytic effect of chloride is manifested in the entropy of activation, which is estimated at 9 e.u./mole for 1.5 N chloride in contrast to -29 e.u./mole in the absence of chloride.

1866 The photolysis of methyl iodide. Robert D. Schultz and H. Austin Taylor. AECU-481, nd. 11p.

The photolysis of methyl iodide by 2537 A radiation has been investigated under varying conditions of light intensity, temperature, iodine removal by rotating silver vanes and added carbon dioxide. Methane production is independent of temperature in the range 40° - 100°C, directly dependent on the light, nearly independent of efficiency of iodine removal and is inhibited by carbon dioxide. Ethane production increases rapidly as the efficiency of iodine removal is increased. It is argued that methane results from the reaction, with iodide, of "hot" methyl radicals produced in the primary reaction. Ethane is formed from the association of cold methyl radicals. A possible decrease in ethane production with increase in temperature can be accounted for by the reaction of $CH_3 + I_2$ having an activation energy of ~1 kcal.

1867 Physical properties of some metal halide-phosphorus oxychloride complex compounds. D. M. Gruen and J. J. Katz. AECU-498(UAC-123), June 1949. 7p.

An interesting class of compounds which has received relatively little attention are the complexes between metal halides ($TeCl_4$, $SbCl_5$, $TiCl_4$, BCl_3, $AlCl_3$, $SnCl_4$, $FeCl_3$) and $POCl_3$. In connection with other work, some physical properties of $HfCl_4$ and $ZrCl_4$ complexes with $POCl_3$ have been examined. The vapor pressures of these compounds were determined and the value 20.5 ± .5 kcal. found for the heat of vaporization of both complexes. The boiling points are 360° and 355° C for the hafnium and zirconium complexes, respectively. The highly associated nature of the complexes in the liquid state indicated by the value 32 for Trouton's constant was corroborated by freezing point depression measurements in hexachlorobenzene. The formula $2ZrCl_4$-$POCl_3$ suggested by van Arkel and de Boer (*Z. fur anorg. chem. 141*, 289-296(1924)) was found to be in error but the formula $3ZrCl_4$-$2POCl_3$ appears to be in excellent agreement with the analytical results. The question of the molecular constitution of these complexes raised by the new formula is examined in the light of vapor density measurements (molecular weight in the vapor phase) and surface tension measurements (parachor values).

1868 Studies in the systems inorganic salt-water-organic solvent. IV. Spectrophotometric studies of cobaltous chloride. Leonard I. Katzin and Elizabeth Gebert. AECU-500 (UAC-124), nd. 5p.

The cobalt chloride behavior in a number of organic solvents has been studied with the aid of a Beckman quartz spectrophotometer. Solutions of cobaltous chloride in methanol show a color change depending on the concentration of the salt. In the more dilute solutions the color is red, and as the concentration is increased more of a blue appears in the solution. Experi-

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mental data with cobalt chloride in acetone indicate that the major absorption is due to a complex containing 3 chlorides per cobalt. It is further indicated that this complex entity is produced by complete disproportionation of a cobaltous chloride entity. Additions of small amounts of water to the solutions in acetone, tertiary butyl alcohol, and dioxane, seem to reduce all parts of the absorption curve above about 550 mμ proportionately. At the highest concentrations of water (vicinity of 15% and higher) the absorption in the red region approaches zero, leaving only the usual cobalt peak.

1869 Basic chemistry of gallium: the stability of gallium halide complex ions in aqueous solutions. August 1, 1947 - June 30, 1949. Henry Taube and Archie S. Wilson. University of Chicago, nd. 17p. (NP-1060).

The present report describes experiments which have been made in an attempt to measure the affinity in water solution of gallium ion for fluoride ion, chloride ion, and bromide ion. For the Ga^{+3}-F^- system, qualitative experiments only have been done, which suffice to afford a comparison of stability with the fluoride complexes of ferric ion and gallium ion. For the Ga^{+3}-Cl^- and Ga^{+3}-Br^- systems, quantitative measurements have been made. The complex ions of Ga^{+3} and F^- are sufficiently stable so that the solution of LaF_3 in Ga^{+3} is appreciable. The affinity of Ga^{+3} for F^- is considerably less, however, than that of Al^{+3} or Fe^{+3} for F^-. In both of these systems the affinity of gallium ion for the halide ions is so low that values for the association constants could not be determined. The experiments do, however, place rather low upper limits on these equilibrium quotients: at $\mu = 0.35$ and 25°, the quotient $\frac{(GaCl^{+2})}{(Ga^{+3})(Cl^-)}$ has an upper limit of about 1; at $\mu = 1.3$ and 25°, the corresponding quotient for the gallium bromide complex ion has an upper limit of 0.3. The quotient $\frac{(FeBr^{+2})}{(Fe^{+3})(Br^-)}$ lies in the range 0.02 to 0.1 at $\mu = 1.3$ and 25°. 11 references.

1870 Kinetics of the reactions of zirconium with O_2, N_2 and H_2. Earl A. Gulbransen and Kenneth F. Andrew. *J. Metals 1*, 515-25(1949) Aug.

The kinetics of the reactions of ductile zirconium with oxygen, nitrogen, and hydrogen are studied as a function of time, temperature, pressure, surface preparation, and stability of the particular film. The vacuum microbalance method is used for all of the measurements. 16 figures and 4 tables are included.

1871 The radiometric determination of gold and rhenium in iron meteorites. Harrison S. Brown and Edward D. Goldberg. AECU-495(UAC-82), nd. 6p.

The concentrations of gold and rhenium in a series of iron meteorites have been investigated by the pile irradiation method. A detailed procedure is given for the separation and determination of gold and rhenium, respectively. Gold was analyzed in 45 meteorites and its weight concentration was found to range from 0.135 to 3.65 ppm. Preliminary results gave a rhenium content ranging from 0.335 to 1.95 ppm in 5 meteorites.

1872 The lower oxidation states of ruthenium in acid perchlorate solutions. Philip Wehner and J. C. Hindman. AECU-499(UAC-121), July 1, 1949. 5p.

Analytical methods have been developed for the identification of the oxidation states of ruthenium in aqueous perchloric acid. These methods include the estimation of total ruthenium content by oxidation and spectrophotometric assay as ruthenium tetroxide and coulometric analysis at controlled electrode potentials. Ru(IV) and Ru(III) appear to be the only lower oxidation states readily prepared in acid perchlorate solutions. No evidence has been obtained for the existence in such media of states between Ru(IV) and Ru(III) (ruthenium tetroxide). No state lower than Ru(III) has been detected at oxidation-reduction potentials more negative than -0.1 volt.

1873 Methods of quantitative micro-analysis. Edited by R. F. Milton and W. A. Waters. London, Edward Arnold and Co., 1948. 599p.

Some of the most generally useful microtechniques have been collected in order to aid the chemist who must deal with a rapidly increasing field of available apparatus and techniques in that field. The following main subject divisions are treated: I. Gravimetric apparatus and general microchemical technique. The special characteristics of weighing, filtration, and drying operations on a small scale are considered, and a table is given summarizing suitable gravimetric procedures for the determination of 22 metals. II. Organic microanalysis. III. Volumetric analysis. The de-

CHEMISTRY (continued)

tails of about 35 volumetric methods, both inorganic and organic, are included. IV. Colorimetric analysis. V. Electrochemical methods. Discussions of potentiometry, polarography, amperometry, electrodeposition, conductometric and coulometric analysis, and electrophoretic techniques are given. VI. Gasometric methods. Two broad categories are discussed, i.e., those developed by chemists, often by merely reducing the scale of classical methods, and secondly those first used by the biochemists and physiologists who developed them, and later used by analytical chemists. In most of the discussions the sources of error and manipulative difficulties are considered in detail.

1874 Solvent extraction of inorganic ions. L. G. Bassett, G. E. Wiberley, and J. Savolainen. AECU-380(RPIB-1), May 1, 1949. 21p.

Three methods of attack on the problem of the mechanism of solvent extraction are proposed: infrared absorption studies to determine the structure of the substances extracted, studies of the nature of the interfacial boundaries which determine the rate of establishment of equilibrium, and a study of the effect of small quantities of foreign ions on extraction efficiency using tracer techniques. Progress is reported on the first two phases of the program.

The absorption spectra of several ethers useful in extraction have been determined. A characteristic band for the n-butyl group, hitherto unreported, has been observed at 739 cm^{-1}. The work of Gordy and others suggests that the information of complexes of solvents containing the C-O-C group with inorganic ions in acid solution may be explained by hydrogen bonding. Preliminary data have been obtained which indicate that this is a profitable line of attack.

A study of the physical properties of each of the phases of the $FeCl_3$-isopropyl ether system is being made to determine the nature of the complexes which may be present. Apparatus for determining the potential across the interface of this system is being assembled.

1875 Ion exchange studies. II. The determination of thermodynamic equilibrium constants. J. F. Duncan, B. A. J. Lister, and P. E. Brown. Atomic Energy Research Establishment Report AERE C/R 380, July, 1949. 22p.

A critical examination of the postulates used to evaluate the activities of ions in an exchanger is given, and an experimental test has been made using the barium-hydrogen and lanthanum-ammonium exchange systems. It is shown that the assumption that the activities in the exchanger are proportional to the molar concentrations (in arbitrary units) gives an approximately constant value for the mass product, but even on this postulate the mass product varies by about 50%, rising to a maximum at an equivalent fraction of about 1/3 for the multivalent ion in the exchanger. It is suggested that the activities in the exchanger have been wrongly evaluated because of the influence of some secondary process, such as adsorption, solution of ions in the exchanger, or swelling of the resin.

1876 Thermo-diffusion in the separation tube. H. Ratte. *Z. Physik 126*, 141-74(1949) (in German).

A mathematical picture is given of the processes taking place in a thermo-diffusion separation tube. The discussion is based on the analogies that exist between these processes and the separation of substances through distillation, the main analogy residing in the use of the counter-current principle in both methods. The fundamental equations and relationships of the theory of distillation are here employed for the study of the thermal diffusion.

1877 Studies on the mechanism of action of ionizing radiation. VI. The oxidation of thiols by ionizing radiations. E. S. Guzman Barron and Veronica Flood. AECU-530(UAC-103), nd. 28p.

Thiol compounds, such as glutathione, 2,3-dimercaptopropanol (BAL), propane-1,3-dithiol, and n-phenylaminopropanedithiol, were readily oxidized by x-rays, β rays, and γ rays. The ionic yield for this oxidation was about the same, 3 at pH 7, on irradiation with x-rays and with β rays; it was 23% less on irradiation with γ rays. The ionic yield varied with the hydrogen ion concentration, increasing as the pH value increased. There was no reduction of oxidized glutathione on irradiation with dosages of x-rays and γ rays which produced oxidation of the reduced compound. In the absence of oxygen, the oxidation of thiols by ionizing radiations was only 33% of that obtained in the presence of dissolved oxygen. When the thiol solutions were irradiated in the presence of dissolved oxygen, catalase protected them from oxidation by 17 to 27%. 14 references.

1878 The distribution of the number of ion pairs in the clusters along the track of a fast β-particle in air and in neon. W. J. Beekman. *Physica 15*, 327-9(1949) May.

The probable primary ionization of fast β particles in air and in neon has been previously investigated using a Wilson cloud chamber (*Physica 12*, 534(1946)). Statistical data, which

CHEMISTRY (continued)

were obtained during these experiments, on the number of ion pairs in the clusters along the tracks, have been tabulated. The number of ion pairs is shown as a function of ρH in gauss-cm, in which ρ is the radius of curvature observed in a field, H.

1879 Infra-red spectra of ortho, meta, para, and omega, mono deutero toluenes in 2 to 16 micron region. John Turkevich, Hugh A. McKenzie, Lewis Friedman, and Robert Spurr. AECU-478, nd. 12p. Proposed for publication *J. Am. Chem. Soc.*

The several monodeutero toluenes listed above were prepared by deuterolysis of the appropriate Grignard reagents. The latter were made using the procedures and apparatus of Weldon and Wilson (*J. Chem. Soc. 1946*, 235). The experimental techniques are described in detail. The infrared spectra of these compounds in the 2-16 μ region were obtained in 0.1 mm thick rock salt cells on a Baird Associates Double Beam Recording spectrophometer. The results are tabulated and the absorption curves presented graphically. Absorption curves for the pure compounds and of 10% solutions in carbon tetrachloride are given.

1880 Infra-red absorption band of n-butyl group. Stephen E. Wiberley and Lewis G. Bassett. AECU-505, nd. 4p.

In obtaining the infrared spectrum of a series of ethers it was noted that all of the ethers containing a normal butyl group showed a strong absorption band at approximately 739 cm^{-1} which was lacking in the other ethers. It was considered advisable to confirm whether the band found at 739 cm^{-1} occurred only in butyl ethers or in other n-butyl compounds as well. Eighteen available compounds of varying types but all containing at least one or more n-butyl groups were measured over the region 720-750 cm^{-1}. As proof that the band at 739 cm^{-1} was due to the n-butyl group and not to other terminal groups a few alcohols, esters, and halides not containing a n-butyl group were also run in this narrow region. The data presents strong evidence that an absorption band in the region 734-742 cm^{-1} is indicative of the presence of the n-butyl group.

1881 Spectrophotometric study of cobaltous nitrate in organic solvents. L. I. Katzin and Elizabeth Gebert. AECU-508(UAC-42), nd. 4p.

When cobaltous nitrate is dissolved in organic solvents (e.g., acetone, tertiary butyl alcohol, dioxane) the color changes from the salmon-red of the aqueous solution to a decidedly magenta color of greater intensity. Addition of a small percentage by volume of water causes the color to revert to that of the aqueous solution. Spectrophotometric investigation has disclosed that the essential portion of the spectral change in organic solutions is an intensification of the normal cobaltous ion peak. There is a small shift toward the red in its position. The intensification and peak shift account for the color change observed. When an equimolar concentration of tetrabutyl ammonium nitrate is added to cobalt nitrate in acetone or tertiary butyl alcohol, there is an intensification of the absorption by some 30-40%; a second equimolar portion produces much less effect, and a third none. In ethyl alcohol, a single addition gives no significant effect (less than 5%). With the dioxane solution, a single equimolar portion trebled the extinction. When the addition is two equimolar portions (0.005 M cobalt nitrate), a phase separation takes place, the cobalt concentration in the main dioxane-rich phase being reduced to about one-ninth the original and the extinction coefficient being increased by perhaps a further factor of 2. This behavior indicates that the relatively low extinction of the cobaltous nitrate in dioxane is ascribable to an abnormally high activity coefficient of the water present. Using equimolar solutions of cobalt nitrate and tetrabutyl ammonium nitrate, studies have been made of the stoichiometry of the interaction.

1882 The preparation of formaldehyde-C^{14}. A. Russell Jones and Walter J. Skraba. *Science 110*, 332(1949) Sept. 30.

The production of formaldehyde-C^{14} has been accomplished by an adaptation of the formaldehyde synthesis of Henry and of Michael (*Am. Chem. J. 1*, 418(1879)) using a vacuum line technique. Methyl-C^{14} acetate was prepared by reaction of methanol-C^{14} (Nystrom et al., *J. Am. Chem. Soc. 70*, 441(1948)) with acetyl chloride. The product, chloromethyl-C^{14} acetate was readily hydrolyzed with excess water to produce a formalin solution of any desired concentration containing acetic and hydrochloric acids. Vacuum distillation of this solution gave paraformaldehyde as a residue and a more dilute formaldehyde solution as the distillate. The specific activity of formaldehyde-C^{14}-dimedone prepared by this procedure from methanol-C^{14} (12.00 μc/millimole) was 12.18 μc/millimole as determined by dry combustion and ion-current measurement by means of a vibrating reed electrometer.

CHEMISTRY (continued)

1883 Synthetic plant-growth regulators. I. 2,4-dichloro-5-iodophenoxyacetic acid and derivatives. Winthrop C. Wolfe, John W. Wood, Loraine W. Klipp, Thomas D. Fontaine, and J. W. Mitchell. *J. Org. Chem. 14*, 900-6(1949) Sept.

The synthesis and properties of some new plant-growth regulators, 2,4-dichloro-5-iodophenoxyacetic acid and 15 of its derivatives, are described; the plant-growth regulators were also made radioactive by the introduction of I^{131} into their structures. The apparatus used in the synthesis, the distribution of radioactivity during synthesis, and the possible use of these compounds as a means of investigating the plant-stimulus type of action of the phenoxyacetic group of compounds are described.

1884 Some observations on exchange of CO_2 between $BaCO_3$ and CO_2 gas. George Samos. AECU-474, nd. 6p. Proposed for publication in *Science*.

An attempt has been made to confirm results obtained by previous investigators and to obtain additional information on the factors affecting the amount of exchange of CO_2 between $BaCO_3$ and CO_2 gas. C^{14} was used as a tracer. A small amount of moisture (relative humidity exceeding 3%) is sufficient to cause exchange between $BaCO_3$ and atmospheric CO_2, confirming an observation of Armstrong and Shubert (*Science*, Oct. 24, 1947). Heating the $BaCO_3$ sample will reduce exchange which confirms Yankwich's results (*Science*, June 25, 1948). The amount of exchange taking place depends on the size of the $BaCO_3$ crystals, very large crystals making exchange negligible. The preparation of samples and the experimental procedures are described in detail.

1885 Study of the carbon dioxide-carbon reaction using C^{14} as a tracer. Francis Bonner and John Turkevich. AECU-476, nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

The reaction of CO_2 containing radioactive carbon with charcoal was studied in a recycling system at temperatures from 500 - 830°C. Measurements were made of the change in pressure, specific radioactivity and chemical composition as a function of time and temperature. It was found that in the region of 600 - 800°C the reaction takes place in two steps. In the first step, which is rapid, the carbon dioxide collides with the carbon surface to produce CO and an oxygenated charcoal surface with no change in pressure and no change in specific activity. This is followed by a slow process whereby the oxygenated charcoal liberates carbon monoxide with increase in pressure and a decrease in specific activity.

1886 Studies on the catalytic reduction of acetone. J. Turkevich and L. Friedman. AECU-479, nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

Studies on the reduction of acetone to propane with deuterium on a platinum charcoal catalyst were made in an attempt to determine whether conditions existed for a localized introduction of tracer atoms into molecules by catalytic deuterization methods. Reductions were carried out in both static and flow systems at room temperature and 0°C and finally in a flow system at -70°C, and appreciable exchange of deuterium for the hydrogen in the resultant propane was observed in all cases. Under these conditions, acetone, isopropanol, and propane will not exchange with deuterium rapidly enough to account for the observed exchange nor will mono deutero propane disproportionate and exchange to give protium propane and propane-2-D-2. An experiment in which acetone was adsorbed on the catalyst and then the catalyst bed evacuated and subsequently was flushed with D_2 yielded a product gas which consisted of a mixture of polydeutero propanes. This indicates an exchange and reduction which takes place simultaneously through a chemisorbed molecule of acetone. Experiments to date indicate one cannot localize the introduction of deuterium into a propane molecule by vapor phase reduction over a platinum catalyst.

1887 Nuclear developments in chemistry. William Rubinson. AECU-482, nd. 9p.

The use of radioactive tracers in chemical research is briefly reviewed. Some of the tracer applications discussed include studies of the oxidation states of the ceric-cerous system, the isomerization reactions of paraffins catalyzed by aluminum halides, the reaction of carbon dioxide with graphite to produce carbon monoxide, the Szilard-Chalmers process in neutron bombarded ethyl bromide, and the use of tracers to determine the adequacy of analytical procedures.

CHEMISTRY (continued)

1888 A note on the direct determination of absorption from solution. Eric Hutchinson. AECU-486, nd. 4p.

In the case of sodium dodecyl sulfate an experimental determination of the quantity of solute adsorbed on aqueous solutions has been made by use of a radioactive tracer technique. Radioactive sodium, Na^{22}, was exchanged with some of the normal sodium in a pure sample of the detergent from which aqueous solutions were prepared. Platinum wire of about 0.5 mm diameter was bent into the shape of a circle provided with a stirrup for convenience in handling. The ring was immersed, after gentle flaming, into a solution of the radioactive detergent, and then carefully raised through the surface so that a film of the solution was formed on the ring. Once free of the surface of the solution the ring plus film was rapidly transferred to a weighing bottle and the weight of solution in the film determined. The contents of the weighing bottle were rinsed out and the quantity of radiosodium in the rinsings determined by radioactive assay in the conventional way. By comparing the count of the film material with an equal weight of solution drawn from the bulk of the solution the excess sodium present in the surface of the film was readily obtained. If it is assumed that the number of sodium ions adsorbed on the surface of the film is exactly the same as the number of dodecyl sulfate ions, as seems reasonable, the quantity of sodium dodecyl sulfate adsorbed per unit area may be calculated. Experiments were also carried out on a solution containing 7.0×10^{-3} moles per liter of sodium dodecyl sulfate contaminated with 0.1% dodecanol. Further experiments were carried out on solutions of lauryl pyridinium chloride in which some of the chloride ion was exchanged with radiobromine. A discussion of results is given in each case. The experiments were part of an investigation of the application of the Gibbs adsorption theory to a complex system.

1889 The mechanism of formation of diethyl ether using the heavy oxygen isotope O^{18} as a tracer element. I. Lauder and J. H. Green. *Trans. Faraday Soc. 44*, 808-10(1948) Oct.

The mechanism of reaction between diethyl sulphate and ethyl alcohol has been investigated using the heavy-oxygen isotope as a tracer element. The results show that during reaction, the alkyl oxygen bond in the ester breaks, but not that in the alcohol.

1890 The crystal structure of $ThCl_4$ and UCl_4. Rose C. L. Mooney. *Acta Cryst. 2*, 189-91 (1949) June.

The crystal structure of $ThCl_4$ and of UCl_4 has been determined from x-ray powder diffraction photographs. The structures are isomorphous with a body-centered tetragonal lattice and the space group symmetry is D_{4h}^{19} - $I4/amd$. There are four molecules in the unit cell. The cell dimensions are as follows:

$ThCl_4$	UCl_4
$a_1 = 8.473 \pm 0.003$ A	$a_1 = 8.296 \pm 0.009$ A
$a_3 = 7.468 \pm 0.003$ A	$a_3 = 7.487 \pm 0.009$ A
ρ calc. = 4.60 g cm^{-3}	ρ calc. = 4.866 g cm^{-3}

Positrons have been found for the atoms such that the calculated intensities are in good agreement with observations. Each metal atom is co-ordinated to eight chlorines. Four chlorines are at significantly smaller distances than the remaining four, indicating that the bonds tend toward covalency.

1891 The quantitative analysis of a mixture of monoclinic and cubic zirconia by x-ray diffraction. Pol Duwez and Francis Odell. California Institute of Technology Progress Report No. 4-46, Nov. 10, 1947. 14p. (NP-792).

A method of quantitative analysis of crystalline materials by an x-ray diffraction technique is described in which no internal standard is needed but which depends primarily upon careful preparation of the sample. An x-ray spectrometer employing a Geiger-Müller counter instead of photographic film to record diffraction line positions and intensities is used. This method makes possible the rapid determination of the relative amounts of 2 crystalline species of the same chemical composition. It is estimated that the proportion of either the cubic or the monoclinic form in a mixture can be determined within at least ± 3%. Experimental results are given for study of a mixture of monoclinic and cubic zirconium oxide.

CHEMISTRY (continued)

1892 Fischer Tropsch reaction using deuterium and carbon monoxide. Sidney Thompson and John Turkevich. AECU-477, nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

The reaction of deuterium and carbon monoxide was studied at one atmosphere pressure over a cobalt-thoria-kieselguhr catalyst. The nature of the products will be discussed.

1893 Determination of deuterium in water. Conversion to methyl deuteride and methane and measurement by mass spectrometer. Milton Orchin, Irving Wender, and R. A. Friedel. *Anal. Chem. 21*, 1072-3(1949) Sept.

A method is described and data are given for the quantitative determination of deuterium in water by the reaction of excess methyl magnesium iodide with the water and subsequent analysis of the methane-methyl deuteride mixture by the mass spectrometer. The method was used since a mixture of a hydrocarbon of relatively high molecular weight whose hydrogen atoms are of mass one and the same hydrocarbon containing some deuterium atoms provides a nearly ideal solution suitable for the evaluation of distillation columns operating under reduced pressure. Such mixtures can be analyzed for deuterium by burning the hydrocarbons to water and converting the water to methane and methyl deuteride and this gaseous mixture can then be analyzed with great accuracy by means of the mass spectrometer.

1894 The rare earth industry. Howard E. Kremers. *J. Electrochem. Soc. 96*, 152-7(1949) Sept.

The industrial extraction of cerium and other rare earths from monazite sand is reviewed briefly, and the principal uses of the rare earths are discussed. 13 references.

1895 A method for the determination of uranium content in minerals by using the fission of U^{235}. U. Facchini and L. Orsoni. *Nuovo cimento 6*, 241-54(1949) July (in Italian).

Layers of powdered uranium compounds are irradiated with thermal neutrons, and the pulses counted that are produced in an ionization chamber as a result of uranium fission reactions. The number of pulses is proportional to the uranium content in the sample irradiated, to the sample's density, and to the range of U^{235} fission products in the sample. The uranium content is determined by comparison of the pulse number with that of a sample of a known composition. The apparatus used is described and its theory outlined.

1896 New levels in the uranium spark spectrum (U II). J. C. Van den Bosch. *Physica 15*, 503-22(1949) July.

On the basis of the known classification of the U(II) spectrum, a systematic investigation has been made of several well known differences throughout the spectrum in order to determine the relationships between the two groups of lines which have already been classified. Although the distance between the two lowest levels was not found, 17 levels were added to group A and 63 levels were added to group B; a total of 392 lines were added to the list of classified lines. Thus the classification of 743 lines in the U(II) spectrum is known; these include 756 combinations between 8 odd and 24 even levels in group A, and between 16 odd and 115 even levels in group B. All of the levels and classifications are given.

1897 The Zeeman effect in the arc and first spark spectrum of uranium. J. C. Van den Bosch and G. J. Van den Berg. *Physica 15*, 329-49(1949) May.

New Zeeman effect measurements have been made in the 2500-5300 A spectral range. From these data it was possible to calculate addition g-values, as well as to confirm a preliminary analysis of U(I) and U(II) which had been made. Portions of the spectrum are shown and extensive tabulated data are given. 4 tables, 9 references.

ENGINEERING

1898 Heat transfer lectures. Volume II. Compiled by Don Cowen. NEPA Division Report NEPA-979, June 1, 1949. 345p.

The following 15 lectures were presented at the NEPA Heat Transfer Symposium, Oak Ridge, Tennessee, Dec. 8-13, 1947: Gravitational diffusion from a boundary source, Hunter Rouse; Experiments in heat transfer to air in subsonic and supersonic flow, Joseph H. Keenan; The mechanics and thermodynamics of one-dimensional gas flow, A. A. Shapiro; Geometrical problems in radiant heat transfer, H. C. Hottel; The effect of vapor velocity on condensation

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inside tubes, A. P. Colburn; Thermal problems in fixed bed continuous flow catalytic converters, R. H. Wilhelm; Thermal pressure drop considerations in aircraft heat exchangers, M. F. Valerino; Heat transfer to liquids boiling under pressure, Charles F. Bonilla; Heat transfer through finned tubes, Donald L. Katz; Heat resisting alloys, J. W. Freeman; Heat tranfer to oils in tubular exchangers, O. P. Bergelin; Heat transfer in recirculating atmosphere furnaces, C. A. Siebert; Fundamental heat transfer considerations with illustrations, L. M. K. Boelter, Heat transfer to molten metals, R. C. Martinelli; Shell side heat transfer characteristics of segmentally baffled shell and tube heat exchangers, Townsend Tinker. References are included.

1899 A new vacuum lock for continuously evacuated systems. D. Saxon and J. Richards. AECU-536 (UAC-117), May 1949. 4p.

It is desirable on some types of vacuum equipment to provide a mechanical means of inserting items such as counters, sources, probes, and the like into the instrument without breaking the vacuum. Two such devices are now in use on a 180° beta-spectrometer. One unit facilitates easy replacement of the very thin nylon windows (J. Brown et al, *Rev. Sci. Inst. 19*, 818(1948)) used on the end window GM counter while the other is a source quick change.

1900 Flow of gases in vacuum systems. R. Witty. *J. Sci. Instruments 26*, 316-19(1949) Sept.

Owing to the confusion which exists in the literature concerning the nomenclature and the physical principles involved in the flow of gases, especially in pumps, an attempt is made to give a standardized nomenclature. The following are defined in terms of physical meaning and methods of measuring these quantities: throughput, conductance, intrinsic speed, operation speed, and various forms of efficiency. It is noted that if the total fine side pressure is regarded as the sum of a number of partial gas and vapor pressures, the action of a pump is more easily understood.

1901 Recent developments in vapor vacuum pump design. Maurice E. Bell. Office of Naval Research London Branch Technical Report OANAR-35-48, Nov. 17, 1948. 11p. (NP-861).

The design and operating characteristics of a 17.5 cm 2-stage mercury-vapor metal vacuum pump (P. Alexander, *J. Sci. Instrum. 23*, 11(1946)) using a conical condensation chamber for improved pumping speed and for operation against higher than usual backing pressures is discussed. Glycerol is proposed for use as a pumping fluid, and its advantages and disadvantages for various applications are discussed. A 3-in. single-stage glass pump using glycerol, having a high pumping speed over a wide range of pressure, and working against backing pressures up to 1 mm Hg has been built and tested. Its design and operating characteristics are described. A trap which offers low impedance to the flow of gas but is effective in trapping glycerol vapor is also described. It depends on the fact that glycerol wets copper and can be trapped by a single impact with a cold copper surface.

MINERALOGY, METALLURGY AND CERAMICS

1902 Correlation of physical properties of ceramic materials with resistance to fracture by thermal shock. W. G. Lidman and A. R. Bobrowsky. National Advisory Committee for Aeronautics Technical Note NACA-TN-1918. July 1949. 15p.

An analysis is made to determine which properties of materials affect the resistance to fracture by thermal stresses. From this analysis, a parameter is evaluated that is correlated with the resistance of ceramic materials to fracture by thermal shock as experimentally determined with TiC, BeO, $ZrSiO_4$, MgO, and (94% ZrO_2 - 6% CaO). Resistance to fracture by thermal shock is shown to be dependent upon the following material properties: thermal conductivity, tensile strength, thermal expansion, and ductility modulus (ratio of stress to strain at failure). For qualitative prediction of resistance of materials to fracture by thermal shock, the parameter may be expressed as the product of thermal conductivity and tensile strength divided by the product of linear coefficient of thermal expansion and ductility modulus of the specimen.

MINERALOGY, METALLURGY AND CERAMICS (continued)

1903 Strength and creep characteristics of ceramic bodies at elevated temperatures. M. D. Burdick, R. E. Moreland, and R. F. Geller. National Advisory Committee for Aeronautics No. 1561, Apr. 1949. 53p.

A total of 109 tests has been made to evaluate certain characteristics of six ceramic oxide bodies for high-temperature applications, especially as turbine blades. Primary emphasis was placed on determinations of strength and resistance to creep under tensile stress at elevated temperatures. Additional data for these bodies on bulk density, linear thermal expansion, modulus of elasticity, and effect of water vapor on strength are given.

1904 The capillary rise, contact angle and surface tension of potassium. Lloyd Quarterman and William L. Primak. AECU-532(UAC-107), June 1949. 11p.

The surface tension of potassium was first measured by Quincke (*Ann. d. Physik (Poggendorff) 135*, 621(1868)) using a drop weight method. He reported 37 mg/mm. This was recalculated by G. Meyer (Landolt-Bornstein, *Physikalisch-Chemische Tabellen*, 5th ed. p. 200) who obtained the result 411 dy/cm. The authors recalculated Quincke's results using modern values for the density of potassium (*International Critical Tables*, Vol. II, p. 463) and the drop-weight corrections given by Harkins and Brown (*J. Amer. Chem. Soc., 41*, 519(1919)) and obtained 500-580 dy/cm. The experimental procedure and a sketch of the apparatus is included.

1905 Investigation of possible improvements in the production of zirconium metal. Report No. 2, August 1 to August 31, 1949. Stephen M. Shelton. United States Bureau of Mines. Aug. 31, 1949. 7p. (NP-1034).

The plain iron crucible now used in the regular process limits the temperature for the reaction and also the salt distillation operation to 930°C, since that is approximately the melting point of the zirconium-iron eutectic. A series of three tests were made to compare a cast iron crucible with a mild iron crucible under as nearly identical conditions as possible. The cast iron crucible was found to be unaffected, while the mild iron crucible was ruined by the formation of zirconium-iron eutectic which melted, ran down, and collected in the lower part of the vacuum report. Purified zirconium chloride was passed through a heated pipe and reacted with molten magnesium in a separate reaction vessel with a salt tapping device. The salt was drained from the crucible into a pot without difficulty. The ease with which the salt tapping was accomplished promises favorable results with additions of fused magnesium in view of increasing the reduction capacity.

1906 Some new data on the properties of wrought titanium. F. B. Fuller. *Metal Progress 56*, 348-50(1949) Sept.

Data are presented showing tensile and compressive properties of titanium sheet, flexural fatigue properties, low temperature properties, and some peculiarities in the tensile stress-strain characteristics of titanium.

1907 The tensile properties of uranium at elevated temperatures in the α range. N. Allen. BR-718A, Mar. 4, 1946. 2p.

Cylindrical pieces prepared from a transverse slice of a cast uranium billet were tested at 350° and 600°C in a creep testing unit working at high vacuum. The elongation and yield point were measured and the ultimate tensile strength calculated. The broken test pieces showed a chisel type of fracture.

1908 Titanium - fact versus fancy. N. S. Spence. *Modern Metals 5*, 15-17(1949) Sept. (See also NSA 2-768).

The author presents a short historical account of titanium along with a description of the mechanical and some of the physical properties. The work being done in the alloying of titanium is briefly discussed. The cost of titanium is given as $5.00 per pound.

1909 Notes on prospecting for uranium in Canada. A. H. Lang. Canadian Geological Survey Paper 49-4, 1949. 22p.

This publication contains information, useful to prospectors for uranium, on various general features of Canadian uranium deposits, methods of locating them and local characteristics associated with the occurrence of uranium minerals.

MINERALOGY, METALLURGY AND CERAMICS (continued)

1910 Prospecting for uranium. U. S. Atomic Energy Commission and U. S. Geological Survey, 1949. 123p.

This booklet provides information for uranium prospectors on the following subjects: I. the uranium-bearing minerals (classification, primary, secondary); II. where to look for uranium (vein deposits, deposits in sedimentary rocks, placer deposits, pegmatite deposits); III. testing for uranium (fluorescence, radioactivity); IV. prospecting with the Geiger counter (background count, general reconnaissance, grid survey, care of the counter); V. laboratory assays and selling procedures (sending samples for assay, offering uranium for sale); VI. laws and regulations (licenses, public lands, staking claims, government rights and powers, executive orders); VII. questions frequently asked and glossary; VIII. appendixes (sources of additional information, manufacturers and distributors of portable Geiger counters, domestic price schedules, licensing regulations, mining claims on the public domain, laws and special orders).

1911 Radioactive mineral deposits. Australian Bureau of Mineral Resources, Geology, and Geophysics Pamphlet No. 3, 1948. 36p.

This publication was designed as a guide for uranium and thorium prospectors in Australia. Physical properties, such as color, streak, luster, hardness, fracture, and specific gravity of the uranium and thorium-bearing minerals are summarized and the various methods suitable for detecting radioactivity in minerals are described. Two colored plates show samples of pitchblende (uraninite), autunite, carnotite, monazite, and others of the most important mineral sources of uranium and thorium.

1912 Source-rock of lead ores and the age of the granitic layer. J. Verhoogen. *Nature 164*, 72(1949) July 9. (Letter to the editor).

Recent data on the radioactivity of K^{40} (*Phys. Rev. 74*, 279(1948)) are applied to the problem of determining the source-rock of the lead ores which seem to have originated from a common source in which the products of radioactive decay of uranium have been accumulating continuously since t_o, for 3350 million years. The ratio Pb/U of total lead to uranium-238 in this source-rock at the present time would be about 7.5, a value which seems to fit almost any kind of material, sialic, basaltic or meteoritic (excluding troilite and iron meteorites). Although the association of lead ores with granitic rocks has suggested the probability that the source-rock was granitic, it is concluded from the calculations made that at time t_o the earth must have been entirely liquid except for a crust which was not granitic. The sial could not have formed at this early stage, and cannot, therefore, be the source of lead ores. It appears probable that the sialic crust began to form only when the original amount of K^{40} had been reduced sufficiently by radioactive decay to allow solidification of the mantle, and after the geothermal gradient in the crust had dropped to a value compatible with the crystallization of granite. An alternative explanation may be that t_o is not the age of the earth, but that of the material from which the earth was formed.

1913 Thorium in weakly radioactive substances and rocks. Arlette Hee. *Ann. Geophys. Strasbourg Universite, Faculte des Sciences, Institut de Phys. du Globe 4*, Pt. 3, 30-59 (1948).

The role of thorium in weakly radioactive substances and rocks, and the variations, if any, produced by thorium in their radiation has been investigated. The results showed that in weakly radioactive substances the apparent effect of thickness is due to the liberation of thoron (Rn^{220}) which depends on the permeability of the medium to gases, as is also the case with thorium minerals. When $Fe(OH)_3$, which facilitates the diffusion of thorium emanation was added to the powdered sample of rocks the previous observation that the effect of thickness is not proportional to the amount of thorium was confirmed. The rocks studied included travertines and arkoses. Results suggested that radioactive prospecting would be aided by a knowledge of the permeability of rocks to radioactive gases.

1914 Where are uranium and thorium stored in the Archean basement? Robert Schwinner. *Geof. pura e appl. 14*, Nos. 1-2, 10-36(1949) Jan.-Mar. (in German).

The author advances a theory which makes it possible to predict where prospecting for new deposits of uranium and thorium should prove successful. According to this theory, such deposits occur chiefly where the equatorial and the meridional branches of the oldest primitive rock systems cross one another. An outline of the earth's Archean basement is included.

PHYSICS

1915 Local production of mesons at 11,3000 feet above sea level. Oreste Piccioni. AECU-468, nd. 2p.

This document is in abstract form; it is reproduced below in its entirety.

A Geiger-Müller assembly registering local hard showers and delayed coincidences associated with such events, has been operated at Berthoud Pass, Colorado (el. 11,315 ft.). As previously reported (New York Meeting of the American Physical Society, January 29, 1949) the rate of occurrence of the delayed coincidences associated with hard showers has been found to change only by a factor 1.1 ± 0.1 when the absorber where decay electrons are produced is changed from sulphur to carbon. The delayed coincidences associated with normal particles, that is, those not producing hard showers, were found to change by a factor $1.85 \pm .05$ in the rate of occurrence, when carbon replaced sulphur as absorber. Hence, mesons associated with hard showers are inferred to be π mesons, produced locally in the lead of the apparatus.

To obtain information on the properties of mesons among the secondary particles of a hard shower, the following procedure was followed, making use of an absorption measurement together with the delayed coincidences counting rate. The apparatus counted the number, N_f, of the secondary particles which emerge downward out of the block of lead (430 gm cm^{-2}) but fail to cross an additional 82 gm cm^{-2} iron absorber. By comparing N_f with the number of registered delayed coincidences, N_D, both numbers referring to the same amount of time, the conclusion is reached that the large majority of the secondary particles emerging from the lead block are to be identified as mesons.

The ratio $\frac{N_f}{N_D}$ is also discussed in view of the fact that it shows no evidence of any interaction between iron nuclei and locally produced π mesons before the end of their range. A lower limit of about 1000 gm cm^{-2} for the mean free path of π mesons before they are absorbed or scattered by interaction with iron nuclei is tentatively established. The average energy of the mesons can be estimated to be a few hundred Mev.

1916 Latitude effect of local penetrating showers. Thomas G. Walsh and Oreste Piccioni. AECU-469, nd. 3p.

This document is in abstract form; it is reproduced below. An experiment on local penetrating showers has been performed aboard a B-29 airplane while flying at different elevations and at two different latitudes: Rome, New York, geomagnetic latitude of 55.13°, and Canal Zone, Panama, geomagnetic latitude of 20.7°.

The apparatus registered local penetrating showers by counting the coincidences AB (C + D) between the trays A and B and either one of the trays C and D. The coincidences AB were also registered. They furnish the intensity of the normal hard component which at the altitude of 30,000 feet must contain an appreciable fraction of protons. The altitude dependence of the AB (C + D) coincidences shows an absorption coefficient of 113 ± 2 gms cm^{-2} both at Rome and Panama. The ratio $\frac{AB\ (C + D)\ Rome}{AB\ (C + D)\ Panama}$ was found to be $1.11 \pm .019$.

Using the values computed by Vallarta *(Phys. Rev. 74,* 1837(1948)) for the minimum energy of the primaries arriving at the top of the atmosphere, it is concluded that the particles arriving on the apparatus and producing an AB (C + D) event have an energy above 8 Bev, and are mainly primaries that have not suffered by collision. The latitude effect for the hard component AB, and for the local penetrating showers AB (C + D) at various altitudes are tabulated.

1917 Heavy particles in cosmic ray stars. M. Blau, M. M. Block, and J. E. Nafe. AECU-470, nd. 6p.

Stars with heavy particles are reported from scanning nuclear emulsions which had been exposed for 3 hrs. at an altitude of 93,000 ft. in Minnesota ($\lambda = 55°$ N). The heavy particles ($z \geq 3$) are believed to be secondary particles of the kind previously reported by Bonetti and Dilworth (*Phil. Mag. 40,* 585(1949)) and Hodgson and Perkins (*Nature 163,* 439(1949)). The tracks in an emulsion are described in detail with reference to a photographic reproduction. Information on direction and characteristics of particles is inferred.

1918 Path of mesons in high pressure cloud chamber with intense magnetic field. R. W. Safford. AECU-485, June 1948. 22p.

When a particle is observed in a cloud chamber near the end of its path or in a high pressure cloud chamber the rate of loss of energy is very great and the percentage change in curvature is

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large. It is of interest, therefore, to know the nature of the path of a particle under these conditions. The relationship which determines the path of an ionizing particle in a magnetic field is derived. Specific ionization is then expressed in terms of γ, (a constant factor) times the radius of curvature. An equation is evolved which gives rate of change of curvature with arc length as a function of the curvature. It is seen that the mass of the particle merely determines the units of measure of distance, and that the paths of all particles in which the A, B, and H are fixed, are essentially the same, except for the units of measure. Thus, the path of a meson of mass 10 Mev is a 200-fold magnification of the path of an electron in the same medium and magnetic field. It is thus the constants of the gas, A and B (constants of the medium through which the particle passes) and the magnetic field H which determine the shape of the path of a particle. The possibility of using the path of a particle to determine its mass, as in the case of a meson is considered. The probability of obtaining meson endings and decays in the chamber on a basis of the geometry, the absorbing material, and the magnetic field is discussed with reference to a proposed cloud chamber for Brookhaven National Laboratory (*Phys. Rev. 73,* 1241 (1948)). Results of calculations show that meson tracks will end in the high pressure cloud chamber after penetrating the magnetic field, and that the probability of endings is of the same order as that of a high pressure cloud chamber without magnetic field.

1919 Angular distribution of rays in the disintegration stars produced by cosmic rays. G. Lovera. *Nuovo cimento 6,* 233-4(1949) May. (in Italian).

A criterion is given of a statistical distribution of rays in "stars," which requires measurements of angles in a projection plane parallel to the surface of the emulsion. (The method proposed by Perkins, *Nature 151,* 486(1948) requires measurements of angles in space.) The author's procedure, based on a probability formula worked out by Feller, (*Phys. Rev. 57,* 906(1940)) was tested on radioactive α emissions, with good results. Measurements are in progress with a view to apply the criterion to cosmic rays.

1920 Frequency of stars of different sizes produced by the cosmic radiation in photographic plates exposed at 29,000 meters. Margherita Addario and Sara Tamburino. *Phys. Rev. 76,* 983-4(1949) Oct. 1 (Letter to the editor).

Tabulated data are given on the number of stars observed in Ilford C2 (unloaded) plates of 100μ thickness which had been carried to 29,000 m in balloons launched at 55°N geomagnetic latitude. The results are compared with the data obtained by Bernardini et al. (*Phys. Rev. 74,* 845(1948)) at 3500 m. From the comparison it is concluded that the radiation which produces stars of three or more prongs is absorbed in air (at altitudes between 3500 m and 29,000 m) with a mean free path of approximately 137 g/cm^2. The frequency of occurrence of stars having more than four prongs is in agreement with earlier results obtained by Salant et al (*Phys. Rev. 74,* 694(1948)). A plot of the number of stars observed at 29,000 m as a function of the star size is also given and compared with the results obtained by Bernardini. The radiation which produces the largest stars appears to be more strongly absorbed in air than that which produces the stars of small size. The results obtained lead the authors to conclude that the different size distribution of the stars observed at different altitudes can be explained by assuming that the star primaries have the same nature at both elevations, but have greater energies at higher altitudes.

1921 Investigation on the meson spectrum at sea level. Karl-Heinz Höcker. *Z. Physik 125,* 780-800(1949).

In two previous papers, (*Z. Physik 124,* 351 and 392(1948)), the author presented a hypothesis on the genesis of cosmic rays, which was based on the existing experimental material concerning the radiations in the upper layers of the atmosphere. One of the main features of the theory is the idea that the particles generated by the primary protons are neutral mesons, neutrettos, that, on their way through matter, and being scattered by the latter, are transformed into charged mesons; these, again, through scattering by neucleons, give rise to neutrettos, etc. In the present work, this hypothesis is used for the calculation of intensities of radiations and of meson energy spectra at sea level. The author's genetic scheme seems to account for the known facts better than does the theory of a direct generation of charged mesons by protons, (Hamilton, et al., *Phys. Rev. 64,* 78(1943); Bethe, *Bull. Am. Phys. Soc. 21,* No. 5(1946)).

PHYSICS (continued)

1922 Meson background in penetrating shower experiments. Guiseppe Cocconi. *Phys. Rev. 76,* 984-5(1949) Oct. 1 (Letter to the editor).

The results of previous experiments (*Phys. Rev. 75,* 1074(1949)) have been extended and clarified by taking data in a tunnel, under a thickness of rocks equivalent to 2,000 g/cm^2 of water (two atmospheres). Coincidence data taken using absorbers of 2 in. of Pb, 2 in. of Fe, 5 in. of Pb, and 6 in. of Fe are tabulated. The results obtained necessitate a revision of the conclusions previously reached. The meson background is estimated as $0.3h^{-1}$, whereas previously it had been considered to be negligible. When the meson background is subtracted from the earlier data, the absorption curves obtained at 260 m and 3,260 m approach a pure exponential shape. This correction eliminates the disturbing variation of the mean free paths with absorber thickness. After correction for meson background, the absorption mean free path in air of the nucleonic component of showers was found to be approximately 120 g/cm^2.

1923 The mesons of the cosmic rays. G. Puppi. *Nuovo cimento 6,* 194-9(1949) May (in Italian) (See also NSA 2-1357).

An attempt is made to give a comprehensive theoretical picture of the main facts involving the two types of mesons known at present. It is assumed that the π meson is a Bose particle responsible for the nuclear forces, while the μ meson is a Fermi-Dirac particle. The processes analyzed are the disintegration of π into μ, the capture of a negative bound μ, and the spontaneous decay of μ. The results agree with the experiment. Between the three Fermi-Dirac particles, (nucleons, μ mesons, and electrons), a peculiar Fermi-interaction is discovered in which the three coupling constants are equal; one of the interactions involved, viz., that between the nucleon and the μ meson, can also be described by a field (the π meson).

1924 Mesons old and new. Joseph M. Keller. *Am. J. Phys. 17,* 356-67(1949) Sept.

The properties of mesons are summarized and the important experimental work which has been done in this field in the last few years is reviewed. 31 references.

1925 Note on the origin of cosmic rays. D. ter Haar. *Science 110,* 285-6(1949) Sept. 16.

The suggestions of various authors that supernovae might be responsible for cosmic rays are reviewed. The author favors the mechanism proposed by Cernuschi (*Phys. Rev. 56,*120(1939)) which differs from that proposed by Hoyle (*Monthly Notices Roy. Astron. Soc. 106,* 384(1946)). Cernuschi proposed the fission of the nuclear lumps as the mechanism and made some estimates of the available energy per fission fragment on the basis of a very crude model of the nucleus. It is suggested that the primary cosmic rays should not be the fission fragments but the neutrons accompanying the fission. Calculations are made which result in an estimate of $Z/A \simeq 1/4$ for the specific charge of the nuclear lumps ejected by the supernova. The packing constant (energy content/unit mass) is determined to be: $f = -1.3A + 0.04A^{2/3} + 15A^{1/3}$ mMU (milli mass units). From this the energy content of the nuclear lump is: $E = Af = -1.3A + 0.04A^{5/3} + 15A^{2/3}$ mMU. Values of "f" and "E" have been tabulated as functions of A (the atomic weight). The data indicate that fission of nuclear lumps with $A \geq 10^5$ will produce energies of the order of the highest observed cosmic ray energies. It is suggested that it might be interesting to investigate theoretically whether the highly unstable nuclear lumps would favor a larger percentage of tripartitions, and the distribution of the fission products over the various Z values. In addition the necessity for a quantitative picture of the supernova outburst and a quantitative statistical picture of the fission of nuclear lumps is noted.

1926 Penetrating particles in the extensive atmospheric showers. P. Budini. *Nuovo cimento 6,* 163-75(1949) May (in Italian).

The penetrating component of extensive atmospheric showers is considered here in the light of the theory of Hamilton et al (*Phys. Rev. 64,* 78(1943)), which recognizes the possibility of the creation of mesons as a result of collisions of photons with protons. The author assumes a similar origin of mesons through collisions of high-energy photons with nuclei, the cross section being proportional to Z. He calculates the spectrum of the penetrating component, its absorption spectrum in lead, and the proportion of penetrating particles to electrons. Taking into consideration the difficulties of the problem, a comparison of the theoretical results with the existing experimental data shows that the author's assumptions can be adopted as a working hypothesis.

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1927 The structure of extensive atmospheric showers. G. Salvini. *Nuovo cimento 6*, 300-2 (1949) July (in Italian).

A model of the structure of extensive atmospheric showers is presented, combining the features of the schemes suggested by Oppenheimer et al (*Phys. Rev. 73*, 127(1948)) and by Greisen (*Phys. Rev. 73*, 521(1948)). Primary protons (10^{13} to 10^{17} ev energy) generate, as a result of a nuclear explosion, mesons, of which 1/3 (neutrettos) disintegrate with the production of photons that initiate the electronic shower, while the other 2/3 (π mesons) produce a cascade of nuclear explosions with a mean free path 300 g/cm^2. The change of the density distribution of the soft component with the altitude is better accounted for by the present model than by the current cascade theory. The model includes also the successive nuclear explosions that have recently been studied by Lovati et al. (*Nuovo cimento 6*, 207(1949)).

1928 Magnet coil cooling. David E. Alburger. AECU-467, nd. 3p. Proposed for publication in *Rev. Sci. Instruments*.

A new method has been developed for the water cooling of strap-wound copper magnets coils, and has been successfully applied to lens-type β-ray spectrometer coils and an iron yoke type magnet. The cooling element is essentially a thin walled cylindrical copper can in the form of a doughnut with inlet and outlet tubes located at points on the rim. A radial baffle between the tube connections causes complete and fairly uniform circulation. The cooling element is described in detail, the advantages pointed out, and a schematic diagram is given.

1929 Low speed microtomy for the electron microscope. Ruth Pinkney Rhoades. AECU-513 (UAC-59), nd. 5p.

An adaptation of a Spencer Rotary Model 820 Microtome is described along with techniques whereby tissue sections of even thickness at 0.1 μ or less can be produced. The wedge idea of Pease and Baker (*Proc. Soc. Exp. Biol. Med. 67*, 470-4(1948)) has been modified in that the wedge of steel, which alters the forward motion of the feed to 0.1 μ rather than 1 μ, is attached permanently to the plane surface of the feed mechanism. The steel surface of the wedge is covered by an optical flat on which a copper disc rides. A special, hollow-ground steel knife is used for cutting the sections.

1930 Cooling methods for electronic equipment in general. R. B. Gelbard, W. Robinson, and S. R. Butler. Ohio State University Research Foundation. Aug. 20, 1948. 35p. (NP-1014).

A survey of heat transfer literature has been made to collect data on cooling by free and forced convection which would be applicable to the calculation of heat dissipation from electronic components. Practically no fundamental data have been found which are directly applicable to the particular configurations, i.e., short cylinders and prisms in multiple arrangement, represented by electronic components. Therefore, related data on long shapes, flat plates, effect of adjacent surfaces, multiple tubes, and local heat transfer coefficients are presented in this report. Suggestions for the calculation of approximate rates of heat dissipation of electronic components are given which serve as estimating methods but would not be adequate for design purposes. 18 references.

1931 Instruments for measuring radioactivity and temperature in boreholes. R. Guelke, J. C. R. Heydenrych, and F. Anderson. *South African Science 2*, 68-70(1948) Oct. (Letter to the editor).(See also NSA 3-336).

Brief descriptions are given of instruments which have been developed for use in the small boreholes used in drilling for oil in South Africa. These holes are 2 in. in diameter, as compared with the 5-in. holes made in America. Typical borehole results are shown for both radioactivity and temperature logs.

1932 The mercury meniscus in precision measurements on gases. R. Whytlaw-Gray and N. Teich. *Trans. Faraday Soc. 44*, 774-83(1948) Oct.

The variations in meniscus volume and in capillary depression in low pressure compressibility measurements are discussed and it is shown that very appreciable errors in high precision work are likely to arise unless these are taken into account. Experiments are described in which an attempt was made to obtain an accurate correlation between meniscus height and meniscus volume in cylindrical tubes of sufficiently wide diameter to reduce the capillary depression errors to small values. In none of the three sets of experiments was the required accuracy attained.

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Finally, a direct measurement of the dead-space volume by means of a mercury pipette after each pressure reading was made. The device used, called the "dead-space pipette," made it possible to determine the dead-space volumes accurately and permitted the use of manometric columns of such a diameter that capillary depression errors are negligible.

1933 Radioactive thickness gage for moving materials. J. R. Carlin. *Electronics 22*, 110-13 (1949) Oct.

An instrument is described for measuring the thickness of moving materials by means of the degree of absorption of β and γ radiations. The material moves between an ionization chamber and a radioactive source. A meter in the basic electrometer amplifier circuit can be calibrated for direct thickness readings. Photographs and circuit diagrams are shown.

1934 Use of radioactive cobalt for sphere gap irradiation. D. R .Hardy and J. D. Craggs. *Nature 164*, 356-7(1949) Aug. 27 (Letter to the editor).

The use of radioactive cobalt, Co^{60}, to provide external radiation for sphere gaps (used in voltage measurements) is described. Electrodes may be machined from cobalt pieces and then irradiated in a pile. Some results, taken with flat electrodes 1.1 cm in diameter, are given. In tests with a one-mgm radium capsule which was enclosed in the cathode 0.7 mm from the surface, cobalt electrodes were also used in order to make the comparison as direct as possible. The curves shown give the ionization current in the gap (measured with an electrometer tube) as a function of the gap-length and voltage. Covering the cobalt with 0.15 mm of copper reduced the gap current by a factor of approximately four, which is an indication of the importance of the β rays.

1935 The isotopic constitution of erbium and lutecium. R. J. Hayden, D. C. Hess, Jr., and M. G. Inghram. AECU-463(UAC-144), Aug. 16, 1949. 2p.

This is not an abstract; the document is reproduced below in its entirety.

During the past two years measurements of the isotopic composition of many of the rare earths have been made. These measurements have recently been extended to cover the elements erbium and lutecium. The mass analyses were made with a 60°, 6-in. radius of curvature mass spectrometer using a heated filament ion source and other techniques previously described. (Ingraham et al, *Phys. Rev. 72*, 967(1947)).

The erbium analyzed was a column separated sample obtained from Dr. D. H. Harris of the Oak Ridge National Laboratory. The observed abundances and the mean deviations in the observations of these values are quoted in the third row of Table I. The earlier photometric results of Aston (*Nature 133*, 327(1934)) (corrected for Dempster's 162 and 164 values) and Wahl (*Finska Kemistsamfundets Medd. 50*, 110(1941)) are also quoted in the Table.

Table I. Isotopic Constitution of Erbium (%)

Observer	162	164	166	167	168	170
Aston*	.25	2	35	24	29	10
Wahl	.1	1.5	32.9	24.4	26.9	14.2
Authors	.139 ± .004	1.53 ± .02	33.4 ± .3	23.0 ± .2	27.1 ± .2	14.9 ± .15

* Values at 162 and 164 were obtained by Dempster (*Phys. Rev. 53*, 727(1938)).

The following limits for other possible erbium isotopes were obtained: 160, 161, and 172 < .01%; 171 < .02%; 169 < .05%. Based on the new values, on the assumption of zero packing fraction for the erbium isotopes, and on a conversion factor of 1.000275 between physical and chemical scales, the chemical atomic weight of erbium becomes 167.28. The international value, chemically determined, is 167.2.

Lutecium was first thought to be a simple element, but the work of Mattauch and Lichtblau (*Zeit. f. Phys. 111*, 514(1939)) showed that, in addition to the main peak at 175, a 2.5% isotope exists at 176. Our lutecium analysis was made on a sample purified by Dr. J. K. Marsh of Oxford and obtained from Johnson, Matthey and Company as Catalog number J. M. 320. The 176 isotope was found to be present to 2.69 ± .05% and consequently the 175 was 97.31 ± .05%. The following limits for other possible lutecium isotopes were set: 177 and 178 < .02%; 173 < .03%; 174 < .06%. With this isotope abundance and assuming zero packing fraction for lutecium and the 1.000275 conversion factor, the chemical atomic weight of lutecium is 174.98. The international value is 175.0.

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1936 Mass assignment of xenon activities produced in fission. Sigvard Thulin, Ingmar Bergström, and Arne Hedgran. *Phys. Rev. 76,* 871-2(1949) Sept. 15 (Letter to the editor).

An electromagnetic isotope separator (*Arkiv Fysik 1,* No. 11, (1949)) has been used to determine the mass-numbers of the Xe isotopes produced in fission. The gaseous fission products from neutron-irradiated uranium oxide were fed to the ion source and the active isotopes collected on a thin aluminium plate. The method of determining the mass numbers, corresponding to the different activities, was the same as used for the mass assignment of 43 min-Hg^{199} and 53 day-Hg^{203}. The results of this investigation and of β-spectrometer data are tabulated. It is noted that the results obtained confirm the Seaborg assignments (Koch et al, *Phys. Rev. 76,* 279(1949)).

1937 A physical method for the separation of nuclear isomers. A. S. Karamyan and L. I. L. I. Rusinov. *Zhur. Eksptl. i Teoret. Fiz. 19,* 651-63(1949) July (in Russian).

A physical procedure is described for the separation of the isomers of Br^{80}. After being irradiated by slow neutrons, ethyl bromide is submitted to the action of an electric field of about 100 v/cm; the radioactive bromine is precipitated on a silver anode. The decay curves are then obtained with the aid of an ionization chamber. It is shown that the isomer separation in this case is due to the presence of metastable isomers of bromine, both in the initial compound C_2H_5Br and in the molecules $C_2H_4Br_2$ that form during the reaction.

1938 The separation tube. VII. Enrichment of heavy xenon isotopes. A remark on the separation of mixtures of many components. Klaus Clusius. *Helv. Phys. Acta 22,* 473-8(1949) Aug. (in German).

The paper that preceded the present one in a series of works on the separation of mixtures was published in *Z. Naturforsch. 2a,* 154(1947). In the present article results are given of the enrichment experiments on xenon isotopes in a 27 m long "separation tube," consisting of a 8.4 mm diameter water-cooled glass tube and 0.4 mm thick Be-Pt wires. From an initial isotope mixture (14 1) with an atomic weight 131.31 a mixture was obtained with the atomic weight 134.32. The Xe^{136} content increased from 8.95 to 44.83%. It is suggested that, for a better separation of isotope mixtures of such high complexities as that found in xenon, gases of appropriate masses and effective cross sections should be added to the original mixture.

1939 Tables of the function $e^{-\alpha z/\gamma} M(\alpha : \gamma : z)$. A. D. MacDonald. MIT Research Laboratory of Electronics Technical Report No. 130, July 15, 1949. 12p. (NP-1041).

Six-figure tables of the function $\mu(z) = e^{-\alpha z/\gamma} M(\alpha ; \gamma ; z)$ have been computed for the following values of the parameters, $\alpha = 0.001, 0.01, 0.1(0.1)1.0, 0.25, 0.75$ (the notation 0.1(0.1)1.0 indicates values of α for 0.1 to 1.0 in steps of 0.1); $\gamma = 0.5(0.5)2.0$, and $z = 0(0.1)1.0(0.5)8$. They may be used in conjunction with tables of the exponential function for accurate values of the confluent hypergeometric function.

1940 Determination of electronic structure of molecules from nuclear quadrupole effects. C. H. Townes and B. P. Dailey. *J. Chem. Phys. 17,* 782-96(1949) Sept.

Nuclear quadrupole coupling constants in molecules depend on the nuclear quadrupole moments and the variation in electrostatic field at the nucleus. It is shown that this variation of electric field is usually simply related to the molecular electronic structure, being primarily dependent on the way in which valence electrons fill the lowest-energy *p*-type orbits. Structural information which can consequently be obtained from known quadrupole coupling constants is discussed. Hybridization of the normal covalent bonds of N, Cl, and As with at least 15% *s* character is clearly shown. The alkali halides appear to be almost purely ionic; the quadrupole coupling data allow no more than 3% covalent character. In addition to molecular structure, some nuclear quadrupole moments are approximately evaluated by use of the theory developed here.

1941 Microwave research. Quarterly progress report May 1, 1949-August 1, 1949. Walter Gordy. Duke University, nd. 32p. (NP-1037).

Three reports are included. *Oxygen-a preliminary report on the fine structure of the microwave absorption spectrum.* James H. Burkhalter et al. The fine structure of the microwave spectrum of oxygen has been observed at low pressures. Lines have been detected with pressures as low as 10^{-1} mm of mercury. This detection was achieved with a Zeeman Modulation Spectrograph which is described in detail. Accurate measurements on the lines are now in progress. *Microwave*

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investigations of chloroform. William V. Smith and R. R. Unterberger. Pure rotational lines of chloroform ($J = 2 \rightarrow 3$ and $J = 3 \rightarrow 4$) have been measured in the K band region and have been used to compute molecular constants of this molecule. *Microwave spectrum and molecular constants of hydrogen cyanide.* J. W. Simmons et al. Precision measurements on the frequencies of the $J = 0 \rightarrow 1$ transition of $HC^{12}N^{14}$, $HC^{13}N^{14}$, $DC^{12}N^{14}$, and $DC^{13}N^{14}$ have been made with multiples of a 10 mc/sec frequency monitored by station WWV. The B_o and I_o values are, respectively: 44300.83 mc and 18.93_{790} mg cm^2 x 10^{-40} for $HC^{12}N^{14}$; 43154.83 and 19.44_{080} for $HC^{13}N^{14}$; 36207.40 and 23.17_{108} for $DC^{12}N^{14}$; 35587.57 and 23.57_{465} for $DC^{13}N^{14}$. The interatomic distances determined are $d_{CH} = 1.061$ A and $d_{CN} = 1.157$ A. The nuclear quadrupole coupling of N^{14} is determined as 4.58 ± .05 mc/sec. Abstracts of current projects on heavy methyl alcohol (CD_3OD), carbon monoxide, and millimeter wave developments are included. Also included is a bibliography of 23 contract publications. 17 references.

1942 Microwave rotational spectra and structures of GeH_3Cl, SiH_3Cl, and CH_3Cl. B. P. Dailey, J. M. Mays, and C. H. Townes. *Phys. Rev. 76*, 136-7(1949) July 1. (Letter to the editor).

Pure rotational spectra due to the $J = 2 \rightarrow 3$ transition of all ten isotopic combinations of Ge^{70}, Ge^{72}, Ge^{73}, Ge^{74}, Ge^{76}, and Cl^{35} and Cl^{37} in GeH_3Cl have been observed. In addition, previously unreported lines corresponding to the $J = 1 \rightarrow 2$ transition of the rarer isotopic species of chlorosilane, $Si^{29}H_3Cl^{35}$, $Si^{29}H_3Cl^{37}$, and $Si^{30}H_3Cl^{35}$ and the $J = 0 \rightarrow 1$ transition of $C^{13}H_3Cl^{35}$ and $C^{13}H_3Cl^{37}$ have been found. Rotational constants obtained from those lines have been measured accurately and are given in tabular form. Hyperfine structure caused by a Ge^{73} nuclear quadrupole coupling in the molecule GeH_3Cl has been observed and a large quadrupole coupling constant is indicated.

1943 Magnetic moments of neutron and proton. O. C. Simpson. AECU-465(UAC-146), Aug. 22, 1949. 5p.

The neutron and proton are assumed to consist of π and μ mesons and of other structural elements wh ich are effectively neutral. Structures for neutrons and protons are postulated from a consideration of the magnetic moment, spins, and masses of the several elements composing these particles.

1944 Neutron diffraction study of glass. A. H. Weber. AECU-491(UAC-35), Dec. 1, 1949. 18p.

This report describes a preliminary exploratory series of experiments on the use of neutron diffraction for investigating the surface and volume structures of glass. The present series of investigations were aimed at introducing hydrogen in glass samples via surface adsorption or volume absorption or both, so as to use the hydrogen as a specific neutron detector. Results are given for studies with glass samples given an outgassing treatment and then exposed in an atmosphere of hydrogen.

1945 Neutron resonance scattering by W^{186}. S. Harris and C. O. Muehlhause. AECU-511 (UAC-51), nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

Lowry and Goldhaber have found a resonance activation integral for W^{186} at 18 ev of 446 barns, and accompanying this, comparable resonance scattering. Using a 4π annular scattering chamber (S. Harris et al, *Phys. Rev. 72*, 866(1947)) we have investigated the epi-cadmium neutron scattering of normal and enriched W isotopes and found large resonance scattering associated with W^{186}. A boron absorption analysis of the resonantly scattered neutrons has yielded a value of ~ 15 ev for the resonance energy. The total cross section and the scattering cross section for self indication have been measured for W^{186} and found to be ~ 16,000 barns and ~ 11,000 barns, respectively. Also the scattering resonance integral by comparison with carbon has been determined for W^{186} and found to be 1100 barns.

The latter value, 100 barns, compared with the 446 barns activation integral indicates that at the 18 ev resonance ~ 70% of the neutrons are scattered and ~ 30% are captured. This is also indicated by the self-detected cross sections. Other figures of interest to be compared with these are: Mn (300ev) – 95% scattering, 5% capture; Au (4.8 ev) – 10% scattering, 90% capture.

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1946 Diffraction of slow neutrons by liquid D_2O. S. J. Czyzak and A. Wattenberg. AECU-512 (UAC-48), nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

An investigation has been made of the relative differential scattering cross section of heavy water in an attempt to obtain information concerning interatomic distances in water. A curve has been obtained at 25°C covering a range in $\frac{(\sin\theta)}{\lambda}$ from 0.1 to 0.9.

Only one pronounced maximum is present at a value of $(\sin\theta)/\lambda = 0.16$ in agreement with previous x-ray diffraction work. (J. Morgan and B. E. Warren, *J. Chem. Phys. 6*, 666(1938).

1947 Review of methods for production of polarized neutrons. M. Hamermesh. AECU-514 (UAC-57), nd. 17p.

The purpose of this report is to analyze the general problem of production of polarized neutron beams. All the methods for neutron polarization which are suggested in the literature are treated as special cases of the general procedure; detailed calculations are given only where the results have not previously been published. The following are discussed: nuclear scattering, magnetic scattering, neutron-proton scattering with tensor force, spin-orbit interaction in the coulomb field, effective spin-orbit interaction in He^4 resonance scattering, polarization by total reflection. 12 references.

1948 Neutron transmission and polarization measurements with an iron single crystal. Merle Burgy, D. J. Hughes, and W. E. Woolf. AECU-519(UAC-73), nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

The transmission of a single iron crystal 2.97 cm in thickness, has been measured as a function of neutron velocity over the range $500\frac{m}{sec}$ to $4000\frac{m}{sec}$. The neutron source was the thermal column of the Argonne heavy water chain reactor. The measurements at various velocity intervals were made with the Argonne velocity selector, and with BeO and graphite filters. The transimission values yield total cross sections which are the sums of the capture and incoherent scattering cross sections, since the Bragg scattering provides a negligible attenuation of the intensity in those velocity intervals in which it occurs.

That part of the incoherent scattering due to energy exchange with the iron lattice can be expected to give rise to a polarization of the transmitted beam (O. Halpern, *Phys. Rev. 72*, 260(1947)). This effect has been found, the associated increase in the transmission with magnetization of the single crystal to 11,000 gauss having been measured as a function of velocity. The results found are in agreement with the assumption that most of the incoherent scattering in iron is due to inelastic lattice scattering.

1949 A method for the absolute determination of neutron flux. F. J. Jankowski and A. Wattenberg. AECU-526(UAC-95), nd. 28p.

Experiments were undertaken to try to determine more accurately the absolute thermal neutron flux in a beam by means of the gold foil technique. The values of the cross sections of gold were remeasured and found to be: $\sigma_{total} = 103.8$ barns; $\sigma_{abs} = 93.0$ barns at 2200 m/sec; and $\sigma_{scat} = 10.8$ barns. The absolute activity induced in the foils was studied by means of the β-γ coincidence counting techniques. The uncertainty in the value of a flux obtained by this technique is thought to be about 3%.

1950 Neutron diffraction in liquid sulphur, lead and bismuth. Owen Chamberlain. AECU-534 (UAC-109), nd. 38p.

A new type instrument has been used to study the neutron diffraction pattern of the elements sulphur, lead, and bismuth in the liquid state. The patterns have been interpreted in terms of the distribution in separation distance of neighboring pairs of atoms. The results for sulphur and lead are in reasonable agreement with x-ray diffraction of others. No other comparable study of liquid bismuth is known.

1951 On the primary spectrum of fast neutrons from a Ra α + Be source, and on their inelastic collisions in Be, Bi, and Pb. M. Teucher. *Z. Physik 126*, 410-21(1949) (in German).

The inelastic scattering of fast neutrons in Be, Bi, and Pb was studied with the aid of a Ra α + Be source occupying the center of a sphere made of the absorbing material under investigation and placed inside an ionization chamber; the latter's walls were coated with uranium or thorium. The energy spectrum of the neutrons was determined by using the tracks of recoil protons

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in the photographic emulsion. The inelastic scattering in the aforesaid metals was characterized by their "transparency," i.e., by the ratio between the numbers of neutrons counted in the presence and in the absence of the absorber. From these transparencies, the following cross sections, in barns, for the inelastic scattering were found: (1) with uranium as indicator: Be 0.32, Bi 1.33, Pb 1.39; (2) with thorium as indicator: Be 0.47, Bi 1.5, Pb 1.75.

1952 Theory of the diffusion of thermal neutrons in a hydrogen-containing substance. Detlof Lyons. *Ann. Physik 4*, 379-88(1949) May (in German).

In Fermi's theory of the diffusion of thermal neutrons in hydrogen-containing substances, (*Ricerca sci. VII-II*, 13(1936); Amaldi and Fermi, *Phys. Rev. 50*, 899(1936)), the anistropic effect due to the chemical bond of the hydrogen atom is neglected. In the present work this effect is taken into consideration. The problem is treated phenomenologically, the distribution law of the scattering angles being assumed unknown. It is found that the theory does not require the knowledge of this law, but only the introduction of the average of cosines of all possible scattering angles, which can be determined from measurements of such magnitudes as the free path of scattering and the albedo. This being done, the ratio between the scattering and the capture cross sections is found by a generalized Fermi's method.

1953 On the tripartition and quadripartition of uranium nuclei. R. Chastel and L. Vigneron. *Phys. Rev. 76*, 870(1949) Sept. 15 (Letter to the editor).

It is noted that the recent reports by Dewan and Allen (*Phys. Rev. 76*, 181(1949)) and Marshall (*Phys. Rev. 75*, 1339(1949)) on the tripartition of uranium nuclei make no mention of the work previously reported by Tsiang, Wei, and the authors, who first published a correct interpretation of the process, published the first mass determination of the light fragment, and also reported the first experimental evidence of quadripartition of uranium nuclei (*J. phys. radium 8*, 165(1947); *8*, 200(1947); *Compt. rend. 223*, 986(1946); *224*, 272(1947); *223*, 119(1946); *Phys. Rev. 71*, 382(1947); *Nature 159*, 773(1947)).

1954 Probability problems in nuclear chemistry. II. W. Bassali. *Proc. Roy. Irish Acad. 52 A*, No. 14, 191-201(1949) May.

Starting with the integral equation previously obtained by Schrödinger (*Proc. Roy. Irish Acad. 51 A*, No. 1), i.e., $\lambda p(r) = \int p(r') \int (r,r')dv'$, for the probability p(r) of a fission taking place at the point r, the following calculations are made: (1) a reasonable expression for the kernel of the aforementioned equation is derived; (2) the Ritz variational method is applied to the solution of the integral equation for the special case of small neutron absorption; and (3) a more accurate solution of the integral equation is obtained by considering the absorption of neutrons as a perturbation.

1955 Nuclear spin and quadrupole coupling of S^{35}. Victor W. Cohen, W. S. Koski, T. Wentink, Jr. AECU-480, nd. 3p.

The rotational absorption transition J = 1→2 of carbonyl sulfide containing S^{35} has been observed at 3646 ± 5 mc/sec. Complete resolution of the spectrum was not attained. However, sufficient resolution of groups of hyperfine components was realized to permit a determination of a spin value for S^{35} of 3/2, the sign of the quadrupole coupling as plus (opposite that of S^{33}), and an estimate of the magnitude of the coupling moment of +20 ±4 mc/sec (corresponding value for S^{33} in carbonyl sulfide is -28 ±0.7 mc/sec).

1956 Precise measurement of the gyromagnetic ratio of He^3. Herbert L. Anderson. AECU-538 (UAC-122), June 25, 1949. 34p.

The gyromagnetic ratio of He^3 was compared to that of H_2 gas by the magnetic resonance method with the result: $\frac{\gamma_{(He^3)}}{\gamma_{(H_2)}} = 0.7617866 \pm 0.0000012$. To obtain the nuclear gyromagnetic ratios, a diamagnetic correction must be made which raises this to: $\frac{\gamma_{He^3}}{\gamma_p} = 0.6718071 \pm 0.0000020$. Intensity measurements were consistent with a spin of 1/2. In nuclear magnetons, the magnetic moment was determined as $\mu_{He^3} = (-)2.12813$ which is based on the value $\mu_p = 2.79353$ obtained by Taub and Kusch (*Phys. Rev. 75*, 1481(1949)). The negative sign has not yet been verified.

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1957 The existence of stable nuclei as related to the principle of regularity and continuity of series and the ends of nuclear shells. William D. Harkins and Martin Popelka, Jr. *Phys. Rev. 76*, 989-91(1949) Oct. 1 (Letter to the editor).

It is noted that in a series of 14 papers published in the years 1917-23 the author (Harkins) established a relationship between the number of protons and neutrons in a particular nucleus and its abundance. The "principle of regularity and continuity of series" is illustrated by means of plots of the isotopic number as a function of the atomic number for four series, i.e., uranium series, helium-thorium series, beryllium series and lithium series. Some of the more important features of the curves are discussed with particular reference to the existence of stable nuclei.

1958 Nuclear magnetic relaxation in metallic copper. N. Bloembergen. *Physica 15*, 588-92 (1949) July.

The magnetic resonance of Cu^{63} and Cu^{65} nuclei has been observed in finely powdered copper at 9.5 Mc/sec between 1° K and 20° K. The relaxation time is inversely proportional to the temperature. At 1.1° K the relaxation time was determined as 0.3 sec. It is noted that it is 15% shorter for Cu^{65} than it is for Cu^{63}. These results are in good agreement with the earlier results of Heitler and Teller (*Proc. Roy. Soc. (London) 155A*, 629(1936)).

1959 Nuclear magnetic relaxation in solids. J. F. Darby and B. V. Rollin. *Nature 164*, 66-7(1949) July 9. (Letter to the editor).

The results obtained with crystals of potassium alum + chrome alum are shown in two tables. An explanation of the effect of paramagnetic ions on the nuclear relaxation process can be obtained by supposing that the electron spin system of the paramagnetic acts as an intermediary between the nuclei and the lattice. The relaxation time is determined by the rate of transfer of energy from the nuclear spin system to the electron spin system. This transfer rate will, in general depend both on the rate of conduction of energy through the nuclear spin system and on the rate of transfer from nuclei adjacent to a paramagnetic ion. An attempt may be made to calculate the interaction between the nuclear spin system and the electron spin system from the magnitude of the magnetic field fluctuations arising from electron spin-spin interaction. The fluctuations may be assumed to be of a random character with a correlation time of the order of ρ', the electron spin-spin relaxation time. Application of the theory of Bloembergen et al (*Phys. Rev. 73*, 679(1948)) leads to nuclear relaxation times which are of the right order of magnitude but are rather shorter than the observed times. Alternatively, one may attempt to calculate the rate of transfer of energy from the nuclear spin system to the electron spin system from a knowledge of the low-frequency absorption coefficient of the electron spin system. Unfortunately, in the presence of electric and magnetic fields, this absorption coefficient cannot be calculated, and experimental values have been obtained only for concentrated paramagnetic substances; it appears, however, that the electron spin absorption is of the correct order of magnitude to explain the observed nuclear relaxation times.

1960 Nuclear spin 5/2 for $_{40}Zr^{91}$. O. H. Arroe and J. E. Mack. *Phys. Rev. 76*, 873(1949) Sept. 15 (letter to the editor).

Evidence that Zr^{91} has a spin of 5/2 has been obtained from the structure of the $4d^2 5s^2\ ^3P_0$-$4d^2 5s(^2P)5p^3S_1$ line at ν_{17777} observed by means of an interference spectrogram. A Zr^{91}-enriched sample of zirconium in a hollow cathode was used.

1961 Theoretical remarks on Crane's and Halpern's experimental evidence for the existence of the neutrino. Roman S. Ingarden. *Acta Phys. Polon. 9*, 109-20(1948).

The relation between the recoil energy of the nucleus in the process $Cl^{38} \rightarrow A^{38}$ and the number of droplets produced in a cloud chamber is calculated using the assumption, made by Crane and Halpern (*Phys. Rev. 53*, 789(1938), *54*, 306(1938), and *56*, 232(1939)), that the number of droplets is approximately equal to the number of nitrogen and oxygen atoms liberated from corresponding molecules as a result of dissociations produced by collision chains that are initiated by the recoil atom. The relation appears to be linear. The occurrence of ions in clusters of droplets is explained as due to x-rays or Auger processes. Statistical errors in the experiments of Crane and Halpern are discussed, the analysis resulting in the conclusion that these experiments definitely establish the non-conservation of momentum in the "two-body" β decay.

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1962 Effect of packing on the critical radius of the sphere. R. Peierls. MS-7A, Sept. 1949. 12p.

An integral equation is set up for calculating neutron density in a uranium sphere surrounded by a packing of scattering material. Solutions of the integral for infinite and specific packing radii are given. Equations are then derived for calculating the critical radius and critical mass of such a sphere.

1963 Solutions of the diffusion equations for generalized reactor shapes. L. C. Merrill. NEPA Division Report NEPA-1075, July 15, 1949. 41p.

The content of this report is strictly limited to the process of obtaining a formal solution of the steady state group diffusion equations for particular geometries. The following are presented: (1) the general procedure for obtaining the solution of a set of diffusion equations by separation of variables; (2) the reactor shapes for which the analytic solutions may be obtained in rectangular, cylindrical, and spherical polar coordinates; (3) the forms of the solutions and the values of the buckling constants; (4) an illustrative example of the one-group diffusion equation for a hemispherical reactor core surrounded by a hemispherical reflector; and (5) graphs of some important variables that occur frequently in cylindrical and spherical coordinates. It is pointed out that there are several more systems of coordinates in which the diffusion equation variables can be separated.

1964 Nuclear isomers produced by slow neutron capture. E. der Mateosian and M. Goldhaber. AECU-518(UAC-72), nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

A systematic search for isomers produced by slow neutrons from the heavy water pile has yielded the following new examples:

Isomer	$T_{1/2}$	Energy of Internal Conversion Electrons	Multipole Assignment
$_{68}Er$	2.5 sec	180 kev	2^4
$_{70}Yb$	6 sec	200 kev	2^4
$_{70}Yb$	50 sec	~10 kev	2^3 or 4
$_{74}W$	5.5 sec	88 kev	2^4

The 50 sec Yb isomer emits only L x-rays, the transition energy is, therefore, of the order of 20 kev.

1965 Disintegration of He^3 and N^{14} by thermal neutrons. J. H. Coon and R. A. Nobles. *Phys. Rev. 75*, 1358-61(1949) May 1.

Cross sections for the n-p reactions induced in He^3 and N^{14} by thermal neutrons have been determined by detecting the disintegrations in a proportional counter. The values obtained are 5040 ± 200 and 1.76 ± 0.05 barns.

1966 The neutrons emitted in the bombardment of B^{10} and B^{11} by deuterons. W. M. Gibson. *Proc. Phys. Soc. (London) 62A*, 586-91(1949) Sept. 1.

An investigation of the neutrons from the (d,n) reactions in B^{10} and B^{11} has been made using the photographic plate method. The separated isotopes were used in the targets. It was found that the reaction $B^{10}(d,n)C^{11}$ results in neutron groups at 6.70 and 4.85 Mev; these give an energy release, from the transition to the ground state, of 6.59 ± 0.10 Mev and the existence of a level in C^{11} at 2.02 ± 0.10 Mev is indicated. The reaction $B^{11}(d,n)C^{12}$ gives well-defined neutron groups at 13.51, 9.40, and 4.55 Mev, with a continuous distribution up to 6 Mev and a small peak at 6.4 Mev. The 13.51-Mev group gives an energy release of 13.92 ± 0.15 Mev for the transition to the ground state; the other groups confirm the existence of levels in C^{12} at 4.47 ± 0.10 Mev, 9.72 ± 0.15 Mev and possibly at 7.7 Mev. The continuous distribution is attributed to the reaction $B^{11}(d,n)3\alpha$.

1967 Neutrons from deuterons on lithium (6). C. E. Mandeville, C. P Swann, and S. C. Snowden. *Phys. Rev. 76*, 980(1949) Oct. 1 (Letter to the editor).

In order to investigate the energy distribution of the neutrons from $Li^6(d,n)Be^7$, a thin target of $Li_2{}^6SO_4$ (300 $\mu g/cm^2$) was irradiated for 15 μ amp-hr with deuterons of 0.90 Mev

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average energy; the latter were obtained by means of a Van de Graaff generator. The recoil protons were observed in Ilford C-2 emulsions and from this the energy distribution of the neutrons from the process has been plotted. The Q-value of the reaction has been determined as 3.30 Mev, which is in good agreement with that calculated from mass values. The results also seemed to indicate that for the alternative reaction $Li^6(d,n\alpha)He^3$ the neutron yield was only half as large.

1968 A note on the $B^{10}(n,\alpha)Li^7$ reaction. S. Devons. *Proc. Phys. Soc. (London) 62A*, 580-6 (1949) Sept. 1.

It is noted that it is difficult to explain the preponderance of transitions to the excited state of Li^7 which is observed in the reaction $B^{10}(n,\alpha)Li^7$ in terms of the usual assumption that the ground state and the first excited state of Li^7 form a $^2P_{3/2,1/2}$ doublet. In addition, the 0.48 Mev doublet would be much larger than would be expected theoretically. If the excited state of Li^7 has a total angular momentum other than 1/2, some angular correlation would be expected between the direction of emission of the α particle, the subsequent γ radiation, and the polarization of the radiation. The correlations expected have been calculated on the assumption that the ground state of Li^7 is 3/2 (odd), that of B^{10} is 3 (odd or even), and that the compound nucleus B^{11} has a definite value of J=5/2 or 7/2. Results are given for excited states of Li^7 with total angular momentum 1/2, 3/2, 5/2, and 7/2 and both even and odd parities.

1969 Photoelectric disintegration of the deuteron. J. S. Levinger. *Phys. Rev. 76*, 699-700 (1949) Sept. 1 (Letter to the editor).

The cross section for the photoelectric disintegration of the deuteron has been calculated using several simplifying assumptions based on recently obtained data (Hadley et al, *Phys. Rev. 75*, 351(1949)). Recent measurements on neutron-proton scattering at high energies are consistent with a Yukawa potential of range $\mu^{-1} = 1.18 \times 10^{-13}$ cm, (about half exchange force, and half ordinary force). The combination of half exchange and half ordinary force gives no force on states of odd orbital quantum number, thus greatly simplifying the calculation. A further simplification is also introduced by assuming central forces and by using an approximate wave function for the Yukawa potential. The calculation is then very similar to the derivation of the Bethe-Peierls formula for zero range of nuclear forces. The curve obtained for the cross section as a function of photon energy (using a Yukawa potential) is compared with that obtained from the Bethe-Peierls formula (*Revs. Modern Phys. 8*, 82(1936), formula (16)).

1970 Resonance effects in the reaction $H_1^3(d,n)He_2^4$. D. L. Allan and M. J. Poole. *Nature 164*, 102-3(1949) July 16 (Letter to the editor).

The excitation function of the reaction

$$H_1^3 + H_1^2 = He_2^4 + n + 17.6 \text{ Mev}$$

has been studied over an energy-range of 90-190 kev using a low-voltage accelerator. A thick target of heavy ice was bombarded with a beam containing tritium ions, and the α particles emitted were observed in a proportional counter. Evidence has been found for a resonance in the cross-section of the reaction for an energy of the incident tritium ions of (155 ± 15) kev. The cross section at the peak of the resonance is several barns.

1971 Thermal neutron capture in nitrogen. R. Batchelor and B. H. Flowers. Atomic Energy Research Establishment Report AERE N/R 370, July, 1949. 13p.

The cross-section for the reaction $N^{14}(n,p)C^{14}$ with thermal neutrons has been experimentally determined relative to 703 barns for the $B^{10}(n,\alpha)Li^7$ reaction. The results obtained is 1.60 ± .04 barns. The reaction obeys within a few per cent the 1/v law in the neutron energy range from 0.02 to 0.1 ev. The author's previous result (AERE-N/R-278) for the cross-section of the similar $He^3(n,p)H^3$ reaction has been accordingly corrected to 3500 barns.

1972 The betatron building and installations at the University of Saskatchewan. E. L. Harrington, R. N. H. Haslam, H. E. Johns, and L. Katz. *Science 110*, 283-5(1949) Sept. 16. (Comments and communications).

The plan of the building which houses the betatron at Saskatechewan is shown and the equipment is described; it is to be used for research both in nuclear physics and in the therapeutic effects of β radiation in the treatment of cancer. The betatron will operate through a range of energy levels up to 25 Mev. Details of the design of the control unit, heat dissipation apparatus and safety precautions are given. Tabulated data are given on the radiation dosage

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received during an 8-hr day (for operation at 24 Mev with an output of 100 r/min at 3 ft) at various points in the building. The first nuclear physics investigations to be made will deal with the determination of the threshold energy for photodisintegration for (γ,p) and (γ,n) reactions in which the product of the reaction is not radioactive. For the investigation of the therapeutic applications of the betatron a d-c amplifier in conjunction with a small probe ionization chamber has been constructed to be used to measure the distribution of radiation within a water phantom. This distribution will be measured for a series of fields and for different types of step filters in an effort to get a clinically useful distribution. After this has been accomplished the machine may be used for cancer therapy.

1973 Electrostatic h.v. generators. Bibliography. L. G. Dobbie. Australia, Aug. 1948. 4p. (NP-1071)

Thirty-six references on electrostatic high voltage generators, covering the period 1933-48, have been compiled from Science Abstracts, Sections A and B.

1974 Paralleling of S-band magnetrons. J. M. Weaver and D. W. Fry. Atomic Energy Research Establishment Report AERE EL/R 341, nd. 10p.

This memorandum describes experimental work done on paralleling two BM 735 magnetrons (Cowhig and Jones, British report AE-1008) with the object of obtaining a higher power source for linear accelerators. Two different waveguide systems were used for coupling the magnetrons: first a shunt T junction and secondly a "rat-race," the latter making it possible to control the degree of coupling between the valves. The experiments showed that while the valves could be made to operate on a common frequency it was impossible to obtain the full power output due to persistent flashing of the magnetrons and jittering of the combined r-f pulse.

1975 Particle accelerators, general. Bibliography. L. G. Dobbie. Australia, Aug. 1948. 5p. (NP-1070).

Forty-nine references covering the period 1931-48 have been compiled from Science Abstracts, Sections A and B.

1976 A 70-Mev synchrotron. F. R. Elder, A. M. Gurewitsch, R. V. Langmuir, and H. C. Pollock. General Electric Research Laboratory, nd. 37p. (NP-1012).

A synchrotron using betatron injection for the production of 70-Mev x-rays has been built and tested. The general mode of operation, and various features of its design and construction are discussed. Some preliminary information on the characteristics of the electron and x-ray beams is included. 15 references.

1977 Synchrotron. Bibliography. L. G. Dobbie. Australia, Aug. 1948. 3p. (NP-1072).

Twenty-nine references covering the period 1942-48 have been compiled from Science Abstracts, Sections A and B.

1978 A symmetrical periodic system of elements according to Pauli's principle. W. Finke. *Z. Physik 126*, 106-7(1949)(in German).

A perfectly symmetrical table of chemical elements is presented, the atomic numbers increasing from 1 to the hypothetical 120. The horizontal rows contain, successively, 2, 8, 18, 32, 32, 18, 8, 2 elements, and the lanthanides (atomic numbers 57-70) and the actinides (89-102) form the end parts, (corresponding to quantum number f), of the two central rows.

1979 Breakdown of ionic crystals by electron avalanches. A. Von Hippel and R. S. Alger. *Phys. Rev. 76*, 127-33(1949) July 1.

In gases at moderate pressures breakdown occurs when the avalanche produced by a primary electron regenerates a new starting electron (Townsend condition). In ionic crystals the breakdown strength appears to be determined by the probability of exciting lattice vibrations, without reference to the electron supply. The theory as formulated to date predicts an increase of the breakdown strength with temperature. Confirming previous results (for both d-c and a-c) an increase followed by a decrease was found. By extending the experiments to transient voltages of rise times down to 10^{-8} sec, and by adopting evaporated metal electrodes and various kinds of irradiation, the influence of field emission and of space charges on the breakdown strength and on the scatter of the breakdown values has been investigated. The occurrence of directional breakdown paths seems to be connected with the Brillouin zones of the crystal structure as the outcome either of electron diffraction or of collisions between electrons and directed lattice vibrations. The possibility of using crystals as Geiger counters is briefly discussed.

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1980 The equations of Codazzi and the relations between electromagnetism and gravitation. Antonio Gião. *Phys. Rev. 76*, 764-8(1949) Sept. 15.

It is demonstrated that quite independently of any physical theory, the general equations of Codazzi (Giao, *Compt. rend. 224*, 1813(1947); *225*, 924(1947); *226*, 645, 1298, 2126(1948)) on differential geometry lead to fundamental relations between the electromagnetic and the gravitational fields as soon as the external metric tensor of space-time is interpreted as an electromagnetic tensor. When the important special case of quasi static fields is considered, for a rotating body with no permanent magnetization: (1) the relation, previously studied by the author, betweem magnetic moment and angular momentum which explains the general features of stellar and terrestrial magnetism as well as the magnetic moment of the neutron is obtained, and (2) a relation between gravitation and the electrostatic field, such that any massive body creates an electrostatic field, such that any massive body creates an electrostatic field by its own gravitation is also obtained. The mean electrostatic fields of celestial bodies, including the earth, can be ascribed to this effect. When the gravitation produced by a given body is negligible (as in the laboratory) the equations of Codazzi show that the familiar coulomb field is merely a consequence of the very rapid vibrations of the components g_{4i} ($i = 1,2,3$) of the internal metric tensor. Finally, for an uncharged body with permanent magnetization it can be shown that the curl of the g_{4i} and the magnetic field are related as cause and effect. It is concluded that these results are a confirmation of a fundamental result of the author's unified field theory, i.e., that the geometrization of electromagnetism must necessarily be achieved by the external metric of space-time.

1981 A graphic-arithmetic method for the simple analysis of energy processes involved in electron movements. Author unknown. Mar. 1944. 32p. (Translated from German by Polamold Research Laboratories, Inc. for Air Materiel Command)(NP-1066).

A graphic method has been developed for simple analysis of the energy processes involved in electron movements. The method deals with finite amplitudes and neglects field distortion. The method is applied to rectangular voltages where the injection current is either constant or rectangular. This leads to the exact mathematical treatment of several problems which yields simple equations for the limit values of the negative alternating field energies and the corresponding plate-electrode distances. With the aid of these results the possible production of 1 cm waves by means of diodes has been investigated.

1982 Luminescence of glasses containing copper, lead, and samarium. T. I. Veinberg. *Izvest. Akad. Nauk S.S.S.R. 13*, 203-8(1949) Jan.-Feb. (in Russian).

The paper contains data on the absorption and luminescence spectra of glasses containing samarium. The influence was studied of the chemical composition of the glass, (B_2O_3 and SiO_2 contents), on the properties of the spectra.

1983 Luminescence of uranyl-containing glasses and crystals. A. N. Sevchenko. *Izvest. Akad. Nauk S.S.S.R. 13*, 188-202(1949) Jan.-Feb. (in Russian).

Experimental proofs are described of the polarized character of the luminescence of uranyl-containing glasses and crystals. The effect is studied in its relation to temperature, extinction time, nature of the salt, its concentration, etc. Twenty-two diagrams and spectrum photographs, 23 references, mostly Russian.

1984 On the general theory of phase transitions. Laszlo Tisza. MIT Research Laboratory of Electronics Technical Report No. 127, June 15, 1949. 33p. (NP-1042).

The theory of phase transitions is developed from fundamental principles of thermodynamics. The discussion is based on the so-called fundamental relation of Gibbs $U = U(X_1, X_2, \ldots X_{r+1})$ expressing the internal energy as a function of the extensive parameters. The quadratic form occurring in the expansion of this function is responsible for the stability properties of the system. If the form is positive definite the system is stable; if it is indefinite, it cannot exist in a homogeneous form but breaks up into two or more phases, each of which satisfies the stability condition. States with semi-definite forms are of special interest. They correspond to the generalized critical points of the system. These include, in addition to the liquid-gas critical point, the various λ-points occurring in many solids and some liquids. The structure of the above-mentioned quadratic forms is studied by transforming them in a sum of squares. This is achieved not by the eigenvalue method, since the eigenvalues turn out to be devoid

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of physical meaning, but by the method of "completing the square." The diagonal terms appearing in this procedure have been evaluated in terms of quantities permitting a simple physical interpretation. The theory is used for a classification of phase transitions. The discussion of the λ-points in ferroelectrics and in the hydrogen halides illustrates the application of the general principles. 20 references.

1985 On the radius of the electron. Erwin David. *Z. Physik 125*, 274-5(1949)(in German).

According to measurements made by Lamb and Retherford *(Phys. Rev. 72*, 241(1947)), the 2S level of hydrogen differs from its 2P levels by an amount that is 0.033 cm^{-1} higher than that required by Dirac's theory. From this the present author calculates a value for the radius of the electron that is about 50 times greater than the so-called classical value.

1986 Solutions of He^3 in He^4. J. W. Stout. *Phys. Rev. 76*, 864-5(1949) Sept. 15 (Letter to the editor).

The change in the λ temperature of He^3-He^4 solutions has been calculated thermodynamically, using the suggestion of Taconis et al *(Phys. Rev. 75*, 1966(1949)) that below the λ point the fugacity of He^3 in the solutions is given by Raoult's law, counting only that fraction of the He^4 atoms which on the two-fluid model of liquid helium are in the normal state.

1987 Variation of grain density with temperature of exposure in nuclear emulsions. Elsie M. Dollmann. AECU-483, nd. 6p.

When scattering and grain density measurements of a number of prongs from stars found in nuclear emulsions exposed to cosmic radiation were compared, an inconsistency was found to exist. Due to the fluctuation in temperature during the balloon flights, a preliminary survey of temperature-controlled neutron-irradiated plates was made. The results indicated that temperature change had caused the reduced grain density, which varied as much as one-third between - 66°C and + 25°C. Correction for this temperature variation caused the inconsistency to disappear (E. O. Salant et al, *Phys. Rev. 74*, 694(1948)). Two groups of experiments are described in which Ilford C-2 unloaded and C-2 boron loaded plates were subjected to various temperature changes before being exposed to a beam of 10 Mev neutrons from the cyclotron at Columbia University. Due to the decrease shown in grain density of tracks at low temperatures and the possibility of mistaking low temperature protons for mesons thereby increasing the apparent meson yield, it was deemed advisable to include temperature recorders or controls in all flights where these nuclear emulsions are used.

1988 Determination of nonlinearity corrections of radioactivity measuring instruments by the method of proportional sources. Truman P. Kohman and Phillip Fineman. AECU-492 (UAC-36), Aug. 18, 1948. 11p.

The most direct and obvious method for detecting and measuring deviations from linearity in the response curve of a radioactivity measuring instrument is by the use of proportional sources, or a series of sources of known relative intensities. A method of evaluating the data from such measurements is described and applied to a self-quenching mica-window Geiger counter, using radium solution capsule standard sources.

1989 Ra DEF standards for absolute activity measurements. T. B. Novey. AECU-497 (UAC-104), May 31, 1949. 2p.

Radium DEF (Pb^{210}, Bi^{210}, Po^{210}) β-activity standards have been prepared from a carrier-free solution of radium DEF in equilibrium in 1N HNO_3. Aliquots of the solution were evaporated over an area of 1 cm^2 on tygon films (~0.7 mg/cm^2) which were fastened with aquadag to aluminum rings. The films were made somewhat conducting with a thing layer of aquadag to prevent field disturbance in the α counter. The samples were spread over this surface by means of insulin solution and dried in a vacuum. α-activity measurements were made in a parallel plate α proportional counter filled with an argon-carbon dioxide mixture. The geometry of the proportional counter was determined by comparison of the counting rate of sources in it with the rates in a low geometry counter in which the geometry is defined by a carefully machined diaphragm and can be accurately calculated. β counting was done with a thin mica end-windowed G-M tube with the sources placed about 4 mm from the window. Corrections were made for counting loss and absorption. Backscattering from the films is small and will cancel out sufficiently well when all sources are mounted in the same way. Absorption corrections are the most difficult to make as the counting rate is very dependent on the position of the absorber. Six standards were

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prepared in this way and calibrated. Four P^{32} sources were prepared similarly from the solution distributed by the Bureau of Standards. Two P^{32} sources were also prepared on palladium clad silver discs for calibration using the Bureau of Standards Ra E standard. Calibration results are tabulated.

1990 A rotating-shutter time-of-flight neutron spectrometer for the resonance region. W. Selove. AECU-520(UAC-74), nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

A high-speed rotating shutter has been built, with characteristics suitable for making time-of-flight neutron cross-section measurements in the resonance region, using a chain reactor as a neutron source. The best resolution available will be about 0.6 microseconds/meter (6 ev at 50, 50 at 200, etc.). This is roughly the same as the best resolution that has been used by the Columbia modulated-cyclotron group. One principal advantage of the new spectrometer is that it is possible to make measurements with relatively small amounts of material; e.g., in measurements on approximately 0.1-gram quantities of the separated isotopes of tungsten it is possible to determine the individual isotope responsible for each of the resonances below 50 ev.

The apparatus will be described, and additional results will be given.

1991 Bibliography. Radiation detection. First edition. Radiation Instruments Branch, AEC, July 1949. 144p.

This bibliography of unclassified and declassified reports and articles on radiation detection consists of the following sections: introduction, detailed index, detector components, count rate meters, ionization chamber rate or integrating meters, scalers, accessories for radiation detection instruments, related instruments, radiochemical laboratory techniques, radiation interaction with matter, health physics, radiation sources, source material for the references.

1992 The characteristics of electronic photomultipliers used as scintillation detectors. I. M. Ageno, M. Chiozzotto, and F. Querzoli. *Nuovo cimento 4*, 217-27(1949) May (in Italian)

The technique of scintillation counters, recently introduced by Broser and Kallmann (*Z. Naturforsch. 2a*, 439(1947)), is being studied systematically. This first report is devoted to the behavior of multipliers of the type 931A when the light intensities are very low. In a preliminary study, it was found that, under the conditions adopted, the leakage current was small as compared with the dark current due to thermionic emission of the photocathode and dynodes. By means of a d-c device, the measurement was made of the trend of the ratio between the current due to a standard light signal and the total dark current, as a function of the feed voltage. In this way, a criterion was found for the classification and the selection of tubes. A compensation of individual differences seems to be possible, within certain limits, through a proper regulation of the feed voltage. In another series of experiments, a study was made of the influence of changes in the voltage between the photocathode and the first dynode on the sensitivity of a photomultiplier. The effect of the temperature decrease, (down to that of solid CO_2), was also measured. The results were confirmed by tests in which scintillations were produced in a naphthalene crystal by γ rays of ThC'' (Tl^{208}).

1993 Counter-controlled cloud chamber with an explosion device. M. Pollermann. *Z. Physik 126*, 261-70(1949)(in German).

A description is given of a cloud chamber controlled by counter pulses, which works faster than the known Blackett apparatus. The expansion is electrically triggered by the pulse, the amplified current producing, by means of a spark plug, an explosion of a gas mixture behind the piston of the chamber. A special contrivance records the duration of the explosion and the movement of the piston, thus permitting the corresponding adjustments.

1994 Electron mobilities in Geiger-Müller counters. H. Den Hartog, F. A. Muller, and C. S. W. Van Rooden. *Physica 15*, 581-7 (1949) July.

Further measurements on the electron mobilities in a self-quenching Geiger-Müller counter, containing various mixtures of argon and alcohol, are described. The electron mobility in a mixture of argon at a pressure of 90 mm and 10 mm of alcohol vapor pressure was determined

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to be 15,700 ±5%, and in 100 mm alcohol vapor pressure (extrapolated) it was 1,640 ± 5% cm/sec per volt/cm. For the range of alcohol pressures covered, i.e., 1.5 - .27 mm (100 mm total pressure), the cross section of argon is negligible except at the lowest pressures. Detailed diagrams are given of the improved chronograph (Hartog et al, *Physica 13*, 251(1947)) and calibrating circuits.

1995 Gamma-ray measurements with a magnetic lens spectrometer. W. F. Hornyak, T. Lauritsen, and V. K. Rasmussen. *Phys. Rev. 76*, 731-9(1949) Sept. 15.

Fffects of instrument resolution and converter thickness on photoelectron lines have been investigated experimentally for γ radiation from 0.4 to 3 Mev. While determinations based on the high energy extrapolated edge of the lines seem to require no corrections for converter thicknesses, the peak value, which does require corrections, is in some cases more easily located. Peak shifts determined for thorium converters near 0.5 Mev are extrapolated to other energies by use of theoretical arguments. Values based on both types of determinations are quoted for γ radiation from the reactions $Li^7(p,p')Li^{7*}$, $Be^9(d,n)Be^{10*}$, and $Co^{60}(\beta^-)Ni^{60*}$. The corresponding excited level transition energies obtained are Li^{7*}: 476.7 ± 0.9 kev; B^{10*}: 713.8 ± 1.3 kev; Ni^{60*}: 1172.4 ± 1.8 kev. and 1330.9 ±2.1 kev.

1996 An investigation of aircraft heaters. XXVI. Development of a sensitive plated-type thermopile for measuring radiation. L. M. K. Boelter, E. R. Dempster, R. Bromberg, and J. T. Gier. National Advisory Committee for Aeronautics Technical Note NACA-TN-1450, July 1948. 66p.

An analysis is presented of the factors determining the power efficiency of radiation thermopiles of that type in which the receivers consist either of parts of the conductors themselves or of coatings or other electrically insulating materials in intimate contact with these conductors. On the basis of this analysis, which is applicable to thermopiles of a wide variety of constructions and materials, criteria for maximum power efficiency are calculated for silver-constantan plated-type thermopiles. The design and construction of thermopiles in accordance with these criteria are described, and test data are reported, showing agreement between actual and predicted performance. It is shown that an approach to maximum power efficiency in a thermopile can be realized independently of its resistance over a wide range. Within this range, therefore, maximum sensitivity in a thermopile to be used with a particular galvanometer or other measuring or controlling device can be obtained by designing simultaneously for maximum power efficiency and for whatever value of resistance is required to produce proper damping, to provide maximum power transference, or to satisfy some other criterion. Calculations are presented for silver-constantan junctions which indicate that it is theoretically possible to obtain, with thermopiles of the type analyzed, about 80% of the voltage produced under equivalent conditions by an ideal thermopile in which the conductors lose no heat by radiation or convection. 44 references.

1997 A mass-spectrographic method for producing graded darkening in photographic plates by means of moderately fast protons. Jens Geerk and Peter Brix. *Z. Physik 125*, 767-79 (1949)(in German).

By the method here described graded darkenings are produced by ion beams on small portions of photographic plates; this eliminates the usual difficulties met with in the preparation of photographic darkening curves for ions. The beam enters a step-like slit placed at right angles to the deviation fields. The inhomogeneity of the canal beam determines a graded current-density distribution in the focal plane, which, for any energy, can be measured electrometrically and can be photographed for subsequent darkening measurement. The optimal position of the slit and the determination of particle energies are discussed, on the basis of calculated electric and magnetic deviations produced in a wide ion beam by means of circular plates. The method was tested experimentally with protons of a few kev energy.

1998 Modified ionization chamber for study of angular distribution of ionizing particles. R. Ramanna and F. C. Champion. *Nature 164*, 226-7(1949) Aug. 6. (Letter to the editor).

A new method of studying the angular distribution of ionizing particles with ionization chambers has been developed and applied to the study of the angular distribution of uranium fission fragments produced by fast neutron bombardment. A plane parallel-plate ion chamber filled with argon gas was used which had a U_3O_8 layer lining its positive plate. Following bombardment of

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the uranium oxide layer with neutrons, the negative ions are collected, amplified, and used to trigger the time base of a cathode ray tube. The positive ions are collected afterwards and applied to the Y plates. Thus, the position of the positive ion pulse on the time base gives a measure of the projection length of the ion track on the electric field. The angular distribution of the fission fragments obtained using a fast neutron Ra-Be source was found to be isotropic. The method is now being applied to the study of the angular distribution of the secondary neutrons from fission, and details will be published elsewhere.

1999 Occurrence of radiation detecting diamonds. L. S. Birks, et al. Naval Research Laboratory. June 4, 1948. 5p.

Tests were conducted to find several "counting" diamonds (i.e., having ability to detect α and γ rays) of varying degrees of sensitivity suitable for further research on the detecting property. A portable electronic counting circuit was built to examine the stones. The stones were placed between 1 fixed and 1 movable electrode in a sensitive electrometer tube circuit and 300-1800 v d-c was applied. Five mg of radium was brought close to the diamond and the pulses produced in the diamonds observed on an oscilloscope. Fifty-five stones were found which showed counting on the test equipment; of these, 38 gave 50-μv pulses or better, and 17 produced detectable but weaker pulses. Stones having counting properties were of gem quality and were clear white except for 2 stones which were slightly yellow but still transparent. No opaque or deeply colored stones exhibited counting.

2000 Optimum conditions for a 180° beta-ray spectrometer. Claude Geoffrion. *Rev. Sci. Instruments 20*, 638-40(1949) Sept.

The relations existing between source dimensions, beam divergence, luminosity, and resolving power of a 180° homogeneous-field spectrometer are established. From these the conditions for maximum luminosity for a given resolving power are derived. By increasing the source height and slightly decreasing the width, the luminosity may be increased without affecting the resolving power.

2001 The photographic plate detects transmutations. M. E. Nahmias. *Science et Vie 74*, 201-7(1948) Oct.

The principles and techniques of photographic plate detection by means of sensitive nuclear emulsions are discussed briefly, and some applications of the method to nuclear physics investigations are noted.

2002 Radioactivity measuring apparatus. The assay of beta and beta-gamma active substances. Denis Taylor. *Chem. Age (London) 60*, 719-21(1949) May 14.

Several different types of apparatus are used for the radioactive assay of β and β-γ active substances. The principle features which govern the operation of each type are described along with a short discussion on counters.

2003 A random operated Wilson chamber for low and high pressures. J. H. Spaa and G. J. Sizoo. *Physica 14*, 642-9(1949) Feb.

The construction details of a 30-cm diameter Wilson cloud chamber, operated by air pressure, are given. The chamber described is as nearly a "universal" chamber as it was possible to construct and is fully automatic, operating at pressures from a few cm to several atmospheres. It is also possible to vary the expansion rate and the gas used. The large diameter of the chamber and the fact that its height may be varied also increase its adaptability. Unlike most chambers of this type, the chamber described is operated by pressures exceeding atmospheric pressure. Detailed schematic drawings are shown; the methods used for producing the magnetic field and the illumination are described and details of operation are given.

2004 Some upper limits of possible alpha-activity. K. Jenkner and E. Broda. *Nature 164*, 412-13(1949) Sept. 3.

The number of α tracks as a function of track length, which were counted in specially prepared Ilford C-2 emulsions (50 and 100 μ thick) loaded with lead and bismuth, are shown. The study was made in an attempt to discover new α emitters. With most elements tested no unidentified tracks were observed; however, a few unidentified tracks are being investigated further. The relationship between the half-life "t" and the number of tracks N, counted in n (usually

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1,000-2,000) fields of view under the microscope, each of volume v, after keeping the plate for a time t', is

$$t = \frac{nvcfAt'\ln 2}{N}$$

if c is the concentration of the impregnating solution in gram-atoms/cc (usually about 5×10^{-5}), and A is Avogadro's number. The 'penetration factor' f is defined as the ratio of the concentrations in the dry emulsion and in the solution. The values of the half-lives thus obtained for Mo, Rb, Zr, Cd, Pb, Bi, Sm, and Th are tabulated. The results also indicate a half-life exceeding 10^{18} years for silver and bromine.

2005 A timing unit for use with Geiger-Müller counters. S. J. Wyard. *J. Sci. Instruments 26*, 308-9(1949) Sept. (Laboratory and workshop note).

A timing device for use with Geiger counters is described which stops the counting after a predetermined time, so that the number of counts recorded can be read off whenever desired. This facilitates making repeated measurements of the number of counts occurring within a given time. The timing unit, which is simple and flexible, is based on the Uniselector switch mechanism. During operation the Uniselector is energized by pulses from a clock, the rotating arm moving at the end of each pulse to the next contact until it reaches a certain contact, preselected by an auxiliary switch, and closes a circuit to stop the counting. A simplified circuit diagram is shown. A supply voltage of 15-50 v (d-c) is required and reliable operation can be obtained at frequencies up to 25 pulses/sec. In the circuit shown, two Uniselectors are used and a maximum of 2400 pulses can be selected, corresponding to a time of 20 min. Although the time is measured in 1/2-sec units it is possible to make a simple change in the circuit which results in a change to units of 1 min.

2006 The width of cloud-chamber tracks of strongly-ionizing particles. M. Pollermann. *Z. Physik 126*, 271-80(1949)(in German).

Photometric measurements were taken on an α-particle tract that was obtained in a counter-controlled cloud chamber. The data were compared with the results of a calculation made on the basis of the measured characteristics of the experiment.

2007 Analytical method for determining transmission and absorption of time-dependent radiation through thick absorbers. I. Radioactivity of absorber, time-dependent. G. Allen. National Advisory Committee for Aeronautics Technical Note NACA-TN-1919, Feb. 4, 1949. 35p.

A theoretical analysis of absorbers whose radioactivity is time-dependent is presented. Matrix methods are employed as a tool in the analytical determination of the intensity of radioactivity and the amount of heat generated in any portion of a thick absorber. The method is applied to the following three cases: (1) plane source of monochromatic radiation of a single type at normal incidence to a plane absorber, (2) plane source of polychromatic radiation of a single type at normal incidence to a plane absorber, and (3) plane source of polychromatic radiation of several types at normal incidence to a plane absorber. Illustrative examples are included. Experimental data on the absorption of gamma rays and neutrons and on the rates of conversion of these radiations to thermal energy are required for utilization of this method.

2008 Ejection of electrons from a metal by fast alpha particles. Harrison E. Kee, Jr. Ohio State University, 1947. 47p.

A thesis is presented on the ejection of electrons from a metal by fast α particles. Electrons ejected from a metal at an angle of 71° 30′ have been examined. This examination was made possible by the construction of an apparatus in such a manner that every electron collected came from the metal at an angle of 71° 30′ ± 30′ without regard to the direction of the incident α. The theory of the shape of this scattering surface is discussed in detail, both as regards the geometry of the apparatus and the collision theory. The experimental work conducted indicates that multiple scattering predominates over single scattering to such an extent that the number of singly scattered electrons collected are not sufficient to be detectable. 10 references.

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2009 High-frequency discharges localized along tracks of ionizing particles. A. R. Bevan. *Nature 164*, 454-5(1949) Sept. 10 (Letter to the editor).

Investigations have been made which demonstrate that an intense high-frequency electric field can produce visible discharges localized along the tracks of α particles and β particles passing through a gas. A thin-windowed closed glass tube was fitted into a cylindrical wire-gauze waveguide which was excited by 1.4 μsec pulses from a 60-kw peak power, 3,000 Mc/sec magnetron. When a radioactive source was placed in front of the window of the tube (which was filled with neon saturated with iodine vapor at a pressure of about 20 cm of Hg) flashes caused by discharges were observed. Photographs of the phenomenon produced with α particles and with β particles are shown. It is suggested that with suitable modifications, and in conjunction with appropriate electronic circuits, this device may be of use as a nuclear physics research tool.

2010 Mean square angles of bremsstrahlung and pair production. Martin Stearns. *Phys. Rev. 76*, 836-9(1949) Sept. 15.

The mean square angles of bremsstrahlung and pair production have been derived and formulas for them are given in terms of the energies of the particles involved, the target material, and the maximum angle up to which the integration is taken. Calculations from these formulas have been made for incident energies between 50 and 300 Mev and for a maximum angle of 20°, and these have been graphed. It is shown that the root-mean-square angle of bremsstrahlung varies as $\mu/E_0 \ln E_0/\mu$, and similarly for pair production. The dependence of the mean square on the maximum angle of integration is briefly discussed.

2011 Proton-proton scattering at 5.11 Mev. R. O. Bondelid, P. G. Bohlman, and K. B. Mather. *Phys. Rev. 76*, 865(1949) Sept. 15 (Letter to the editor).

A coincidence-type scattering chamber, to be described in a later paper, was used to examine the scattering of 5.11-Mev protons scattered by a foil of polyethelene terephthalate. Recording was accomplished by two proportional counters connected in coincidence and set at 90° relative to one another. Tabulated data are given for the scattering angle, the observed cross section, and the ratio of the observed cross section to the Mott cross section.

2012 Theoretical study of electromagnetic waves scattered from shaped metal surfaces. William W. Hansen and Leonard I. Schiff. Stanford University Quarterly Report No. 4 (Final Report), Sept. 30, 1948. 24p. (NP-1065).

A final interim report is submitted on the theoretical study of electromagnetic waves scattered from shaped metal surfaces. The scattering from objects that present no specularly reflecting surface was found especially difficult to estimate theoretically, and consequently that effort was concentrated on obtaining solutions for those shapes for which the vector wave equation is separable. Complete and exact analytical solutions are given for the scattering by a perfectly conducting semi-infinite wedge when the radiation is incident to the axis of the wedge and is polarized both perpendicularly and parallel to the edge. A qualitative physical argument is given for the validity of a result proven analytically, that the width of the penumbral transition from light to darkness along a smooth surface of a given radius of curvature has a corresponding functional magnitude.

2013 On the double beta process. Mark G. Inghram and John H. Reynolds. AECU-464(UAC-145), Aug. 22, 1949. 4p.

A study has been made of the isotopic constitution of xenon extracted from a pre-Cambrian tellurium ore (estimate of age of original sulfide mineralization is 1450 ± 450 million yr) to determine the half-life of the assumed double beta transitions $Te^{128} \rightarrow Xe^{128}$ and $Te^{130} \rightarrow Xe^{130}$. The gases evolved from the ores were collected and purified, and the relative abundance of the xenon isotopes analyzed in a conventional 60° single-focusing mass spectrometer. By comparison with isotopic abundance in normal xenon, lower limits on the half lives of the above beta transitions have been estimated. The following table compares these estimated half-lives with those calculated using the Majorana neutrino theory (Furry, *Phys. Rev. 56*, 1184 (1939)) and the Dirac neutrino theory (Mayer, *Phys. Rev. 48*, 512(1935)).

Transition	$Te^{128} \rightarrow Xe^{128}$	$Te^{130} \rightarrow Xe^{130}$
Majorana theory	2×10^{16} yr	6×10^{14} yr
Dirac theory	3×10^{27} yr	1×10^{24} yr
Author's minimum	1.3×10^{19} yr	8×10^{19} yr

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It appears that the results of this study confirm the Dirac theory. However, the authors point out certain factors which could invalidate the results they obtained.

2014 Half-life determinations and the establishments of genetic relationships. William Rubinson. AECU-472, June 9, 1949. 12p.

All methods of measuring half-lives, or, what amounts to the same thing, decay constants, depend directly or indirectly on the relations (1) $A(t) = \lambda N(t) = A^{o}e^{-\lambda t}$, where $A(t)$ is the activity at time t, expressed in terms of "nuclear disintegrations per unit time"; $A^{o} = A(O)$; $N(t)$ is the number of nuclei of the given radioactive species at time t; and λ is the decay constant of this species. The "half-life," ordinarily denoted by $T_{1/2}$, is defined as the time required for the activity to fall to one-half its initial value. The half-lives of very long-lived radionuclides are determined by use of the relation $A(t) = \lambda N(t)$. A method is described which is commonly used to measure very small λ's (i.e., very large half-lives). For radionuclides which undergo appreciable decay in reasonable times it is much more convenient to determine the half-life by following the change of activity with time. In any case, the domains of applicability of the two methods overlap. For instance, in *Phys. Rev. 72*, 972,973(1947) are two notes on the half-life of tritium. Novick uses what is essentially the method of $\lambda = \frac{A}{N}$ and gets the value 12.1 ± 0.5 yr; Goldblatt et al uses the change of activity with time and gets the value 10.7 ± 2.0 yr. The smallest half-lives measurable by the method of $\lambda = \frac{A}{N}$ are probably of the order of a few months; the change of activity with time may be used to measure half-lives as great as 1500 yr, according to Segrè and Wiegand (*Phys. Rev., 75*, 39(1949)). The greatest half-lives that can be measured with present techniques are of the order of 10^{16} years. For radionuclides with half-lives between a few minutes and a few years, the half-lives are obtained from the time dependence of the activity expressed by equation (1). All that is needed for this purpose is a radiochemically pure source of sufficient activity, and a radiation-measuring instrument whose characteristics do not change in the time period over which the measurements are made. If the activity is that of a single radionuclide which decays to a stable nuclide, the half-life is computed from the observed dependence of radiation rate on time. This is usually done graphically. In principle, a more accurate half-life can be obtained by fitting a curve to the data by the method of least squares. In practice, however, the results so obtained seldom differ much from those obtained using the cruder graphical method. Theoretically, the most accurate value of the half-life is obtained by use of the formula, $T_{1/2} = \frac{0.693t}{\ln R}$, where R is the ratio of the total number of counts between zero and infinity to the number of counts between t and infinity, and t is chosen so that R is about λ This result is a consequence of a statistical analysis mad by Peierls *(Proc. Roy. Soc. (London) [A] 149*, 467(1935)). If the observed decay of a rad active source does not follow the simple exponential law, then the observed activity is a sum of two or more different activities. It is easy in principle, and in practice as well, in most cases, to analyze the decay curve into its component activities. First, by appropriate chemical operations it can be assured that all the initial activity (i.e., the activity at time t = 0) is that of isotopes of a single chemical element. Then other possibilities are presented. It is possible to determine parent half-lives by observations of the daughter activity only. Methods are discussed. Mention is made of the measurement of very short half-lives, those of the order of magnitude of a second and less. Such measurements depend upon special circumstances and the ingenuity of the experimenter.

2015 On the half-life of Na^{22}. L. Jackson Laslett. AECU-504, nd. 4p.

The decay of a Na^{22} sample prepared by the bombardment of Mg metal by deuterons has been followed for 3 years. The resultant decay curves, shown for 2 different source positions, indicate a half-life of 2.60 years.

2016 The beta spectrum of Tm^{170}. D. Saxon and J. Richards. AECU-515(UAC-67), nd. 5p.

Using a purified sample of Tm_2O_3, the β spectrum of Tm^{170} has been measured in the 180° spectrometer. A single half-life of ~ 120 days is indicated. The internal conversion lines of a single γ ray of energy 85.5 ± 0.5 kev are shown in the momentum spectrum. Conversion coefficients have been found by comparing the areas under the lines to that under the β spectrum. Extrapolating from a Kurie plot of the β spectrum, the β end point has been found to be 970 ± 10 kev. From the end point and half-life, the ft value is obtained as 6.3×10^{8}. This places Tm^{170} high in the second forbidden empirical classification. 11 references.

PHYSICS (continued)

2017 The capture γ-ray spectrum of cadmium. Bernard Hamermesh. AECU-516(UAC-70), nd. 1p.

This document is in abstract form; it is reproduced below in entirety.

Photographic plates soaked in D_2O may be used for γ-ray studies (G. Goldhaber, *Phys. Rev. 74*, 1725(1948)). By measuring the range of the photoprotons resulting from the photodisintegration of the deuteron the γ-ray energies may be determined. The method is limited to γ-ray energies above 3.2 Mev.

A beam of thermal neutrons was incident upon a sheet of cadmium placed near an Ilford C-2 plate soaked in D_2O. No neutrons were allowed to strike the plate. A control plate prepared in a similar fashion was used to determine tracks arising from radiation other than capture γ-rays.

56 mm^2 of each of the plates were searched and 301 tracks were found on the γ-ray exposed plate and 40 were found on the background plate. The data were corrected for dip of tracks into emulsion, probability of leaving emulsion, variation of (γ,n) cross section of the deuteron with energy, and difference of range of protons in wet and dry emulsions.

The spectrum shows a continuous spread of energies decreasing in intensity from 3.2 Mev to a cut-off at about 7 Mev.

2018 Transition energies of some nuclear isomers. R. L. Caldwell, E. der Mateosian, and M. Goldhaber. AECU-517(UAC-71), nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

Accurate values of the transition energy have been measured for a number of isomers using a permanent magnet beta ray spectrograph, similar to that described by Hill *(Phys. Rev., 74,* 78(1948)). A special vacuum gate permits the introduction of short-lived samples. Some results are summarized in the following table.

TABLE

Isomer	$T_{1/2}$	Shells from which electrons have been observed	Transition Energy
Co^{60}	10.7 min	K,L,M	58.9 ± 0.5 kev
Cb^{94}	6.6 min	K,L,M	41.5 ± 0.5
Cs^{134}	3 hr	K,L,M	128.0 ± 0.5
Dy^{165}	1.25 min	K,L_I,L_{III},M,N	109.0 ± 0.5
Ir^{192}	1.5 min	L_I,L_{III},M,N	57.4 ± 0.5

2019 A study of the internal conversion electrons of short-lived neutron-induced radioactivities as a means of determining nuclear energy levels. Richard Louis Caldwell. AECU-527 (UAC-96), June 1949. 97p.

A permanent magnet electron spectrograph similar to that described by Hill *(Phys. Rev. 74,* 78(1948)) has been designed and constructed. A special vacuum gate was designed and built which permitted the rapid introduction of radioactive samples into the spectrograph. With this gate it is possible to position a sample in the spectrograph within 12 sec after the end of bombardment of the sample without disturbing the vacuum in the spectrograph. Using this specially equipped spectrograph and the facilities of the Argonne National Laboratory chain reacting pile, accurate measurements were made of the energies of the internal conversion electrons of several short-lived neutron-induced radioactivities. From these electron energies the values of the energy of the metastable nuclear level of 5 short-lived isomers (Cs^{134}, Co^{60}, Cb^{94}, Dy^{165}, In^{192}) and of 2 other radioactivities (Ir^{194}, Tm^{170}) which were not isomers were determined with an accuracy of about 1%. For each of the 5 isomers the angular momentum change between the metastable level and the ground level of the nucleus was determined by each of 2 independent methods. For each of the 5 isomers the relative intensities of the conversion electron lines from the M and N shells, were observed, were measured as well as the intensities of the K and L shell conversion electron lines. The energies of the nuclear levels determined were all less than 150 kev. Because of the high accuracy of both the electron energies and the transition energies, secondary application of these energy values in the establishment of calibration points for absorption curves is proposed. Bibliography included.

PHYSICS (continued)

2020 A proposed decay scheme for $_{72}Hf^{181}$. S. B. Burson and E. der Mateosian. AECU-537 (UAC-120), July 1, 1949. 13p.

A determination of the radiations of Hf^{181} (46 days) has been made by absorption and delayed coincidence methods. The complexity of the beta spectrum is verified and shown to consist of two components of about 0.6 Mev and 0.4 Mev, respectively; and a possible very weak (approximately 1%) third component of about 1.0 Mev. The gamma ray absorption in Pb indicates gamma rays of about 0.5 Mev and 0.34 Mev and a softer component not resolved in these measurements. Delayed beta-e^- and delayed beta-gamma coincidence measurements indicate that the 0.4-Mev beta decays directly to the 22 μsec isomeric state of Ta^{181}. Two internal conversion electron groups coinciding with the delayed 0.40-Mev beta are found to have energies corresponding to the 0.471 and the 0.130-Mev gamma rays previously reported from spectrographic data. Direct coincidences were also observed between the 0.6-Mev beta and the 0.34-Mev gamma ray. No delayed gamma coincidences were observed. A decay scheme is proposed.

2021 Absence of delayed γ-γ coincidences in the decay of hafnium-181. D. Walker and E. W. Fuller. *Nature 164*, 226(1949) Aug. 6 (Letter to the editor)

The 20 μsec metastable state of Hf^{181}, which follows β emission, has been re-examined for delayed γ-γ coincidences using the integral recorder previously described *(Proc. Phys. Soc. (London) 61*, 300(1948)). Two Geiger counters were used in conjunction with an anticoincidence circuit having a resolving time of 2 μsec. The data obtained indicate that not more than 2 or 3% of the disintegrations of Hf^{181} can take place according to the decay scheme proposed by Beneš et al. *(Nature 162*, 261(1948)) which postulates a 0.34-Mev γ transition preceding the metastable state, i.e., a negative result was obtained.

2022 Decay of palladium-109. Kai Siegbahn, Evani Kondaiah, and Stig Johansson. *Nature 164*, 405-6(1949) Sept. 3 (Letter to the editor).

The β emitter Pd^{109} has been investigated by spectrometer techniques. A Fermi plot of the spectrum shows only one component with an upper limit of 0.95 Mev. In addition, two strongly converted lines, corresponding to the K and L lines of a γ ray of 87 kev energy, are observed. It is estimated that the internal conversion coefficient is at least 92% and probably higher. Also, the ratio of the two internal conversion lines, i.e., N_K/N_{L+M}, is 1.3. From this the multipole order of the radiation is either $l = 3$ or $l = 4$; using the Segrè-Helmholz formula (*Phys. Rev. 60*, 415(1941)) to compute the half-life of the metastable state, values of 0.01 sec and 10^5 sec are obtained for $l = 3$ and $l = 4$, respectively. The decay scheme is shown.

2023 The decay of Tm^{170} and Re^{186}. P. J. Grant and R. Richmond. *Proc. Phys. Soc. (London) 62A*, 573-80(1949) Sept. 1 (See also NSA 3-880).

Investigations made with a short magnetic lens β-ray spectrometer and using absorption and coincidence techniques have enabled the authors to suggest decay schemes for Tm^{170} and Re^{186}. The β end point of the former was determined as 1.00±0.005 Mev with possible lower energy groups at 0.90 ±0.015, 0.79 ±0.025, and 0.45 ±0.05 Mev. In addition, γ rays having energies of 82.6 ±0.5, 205 ±10, and 430 ±20 kev were observed for Tm^{170}; the 430-kev radia- appeared to be complex. It was found that the β end point of Re^{186} has a value of 1.090 ± 0.005 Mev, with other groups at 0.95 ±0.015 and 0.64 ±0.03 Mev. Three γ rays were observed for this isotope, with energies of 700 ±50, 275 ±8, and 133 ±1 kev.

2024 The disintegration energy of Al^{29}. L. Seidlitz, E. Bleuler, and D. J. Tendam. *Phys. Rev. 76*, 861-2(1949) Sept. 15 (Letter to the editor).

The decay scheme of Al^{29} has been re-determined because of its relationship to the deviation from the closed shell scheme which has been observed in the case of the $Al^{28} - Si^{28}$ transition. Following the production of Al^{29} by bombarding Mg with 18-Mev α particles, the absorption curves for single counts and β-γ coincidences were obtained. Contrary to previous measurements (Bethe et al, *Phys. Rev. 56*, 1060(1939)), the absorption curve shows a γ background. A complex β spectrum, consisting in the simplest case of 2 components of 2.5 Mev and 1.4 Mev is indicated and all β transitions are followed by γ radiation. A decay scheme compatible with these data is shown. Both β transitions are allowed with "f.t" = 1.6×10^5 (2.5 Mev) and 2×10^4. The total disintegration energy has been calculated as 3.75 ± 0.25 Mev. The value for Al^{29} is seen to be about 1.7 Mev higher than expected from the neighboring members of the sequence. This may be interpreted as confirming evidence for an especially stable structure of Si^{28} (and Si^{29}), due possibly to a shell closure at Z = 14.

PHYSICS (continued)

2025 Introduction to radiochemistry. G. Friedlander and J. W. Kennedy. New York, Wiley. 1949. 412p.

This text, designed for an introductory course in radiochemistry, is largely concerned with nuclear physics. The theory of nuclear and atomic structure and of radioactive decay, which is necessary, is summarized. Various types of sources are considered and a quantitative treatment of radioactive processes is given. Also discussed are the following: types of decay; interaction of radiations with matter; instruments for the detection and measurement of radiations; statistical considerations; measurement and study techniques; the identification, concentration and isolation of radioactive isotopes; the chemistry of low concentrations; new elements; tracers in chemical applications.

2026 Radiations from indium (114) and barium (140). C. E. Mandeville and E. Shapiro. *Phys. Rev. 76*, 718-21(1949) Sept. 15

Using the general methods and techniques previously described *(Nucleonics 3*, 2(1948)), the decay of In^{114} and of Ba^{140} have been investigated. It was found that In^{114} emits soft conversion electrons (range $\sim$ 20 mg/cm^2) and hard nuclear β rays of 1.89 Mev energy. From lead absorption measurements, quantum energies of 0.15 Mev and 0.70 Mev were obtained. It is suggested that the harder quanta are probably associated with an inner β-ray group constituting less than 1.5% of the total β radiation. A γ-γ coincidence rate of $(0.25 + 0.02) \times 10^{-3}$ coincidence/γ ray was noted. It was found that Ba^{140} emits β rays having a maximum energy of 0.91 Mev and two γ rays having energies of 0.14 and 0.6 Mev, as indicated from absorption in lead. The β-γ coincidence data obtained from Ba^{140} in equilibrium with La^{140} and from Ba^{140} freshly separated from its daughter element, show that the β-ray spectrum is complex and that about 20% of the disintegrations proceed by way of the inner β-ray group which is coincident in time with γ-radiation.

2027 On radioactive nuclei of the type ${}_ZM^{2Z-1}$. B. S. Dzhelepov. *Zhur. Eksptl. i Teoret. Fiz. 19*, 361-82(1949) May (in Russian).

A similar article by the author was published in *Doklady Akad. Nauk S.S.S.R. 62*, 51-4(1948) Sept. 1. It was listed in *Nuclear Science Abstracts* as abstract No. 2-1841.

2028 The analytical content of Schroedinger's wave functions. B. Toushek. *Z. Physik 125*, 293-7(1949) (in German).

This is a discussion of the mathematical bases of Schroedinger's presentation of quantum mechanics, which, in a rather paradoxical way, leads from characteristically continuous eigenfunctions to essentially discontinuous results. The behavior of the parameter functions representing the measurable magnitudes is thus quite different from that of any analytical function. The situation is studied on a simple example of scattering of particles.

2029 Dirac's theory of magnetic poles. W. T. Payne. *Am. J. Phys. 17*, 343-5(1949) Sept.

Dirac's recent work *(Phys. Rev, 74*, 817(1948)) on a new electromagnetic theory based on the hypothesis that magnetic poles exist is reformulated in fairly elementary terms, since the paper in question employs rather unusual mathematical methods and is difficult to follow. The emphasis in the reformulation is placed on the relatively simple basic physical ideas which are involved, and only the case in which all poles and charges are at rest is considered.

2030 Finite relativistic charge-current distributions. D. Bohm, M. Weinstein, and H. Kouts. *Phys. Rev. 76*, 867(1949) Sept. 15 (Letter to the editor).

Preliminary results are reported concerning a method of making Lorentz's theory of the nonpoint electron covariant without either making electrodynamics nonlinear or taking into account the effects of nonelectromagnetic forces which are assumed to hold the charge together.

2031 On the electromagnetic properties of nucleons. Sidney Borowitz and Walter Kohn. *Phys. Rev. 76*, 818-27(1949) Sept. 15.

The methods recently developed by Schwinger *(Phys. Rev. 74*, 1439(1948); *75*, 651(1949); *76*, 790(1949)) for dealing with problems in quantum electrodynamics have been applied to an investigation of the electromagnetic properties of nucleons in interaction with pseudoscalar mesons. The calculated values of the magnetic moments of the neutron and proton are in agreement with results previously obtained by Case (*Phys. Rev. 76*, 1(1949)), Luttinger (*Helv. Phys. Acta 21*, 483(1948)) and Slotnick and Heitler (*Phys. Rev. 75*, 1645(1949)) using different calculational

PHYSICS (continued)

procedures. The result obtained for the neutron-electron interaction is identical with that obtained by Case. Included in this paper are the anomalous proton-electron interaction and qualitative discussion of the scattering of high energy nucleons. The large coupling constants necessary to fit any of the experimental data show that the results obtained by a second order perturbation calculation are not quantitatively reliable.

2032 On the magnetic moment of nucleons. J. Serpe. *Physica 14*, 694-5(1949) Feb. (Letter to the editor)(in French).

The results of previous studies on the magnetic moments of nucleons have been extended using an approximation similar to that used by Luttinger (*Phys. Rev. 74*, 893(1948)). Neutral pseudoscalar mesons were assumed to simplify the calculations. The interaction between the nucleon and the meson depends on two constants, i.e., f_1 and f_2, the pseudoscalar and the pseudovector interactions, respectively; it is assumed that the constants are defined by a system of units analogous to Heaviside's system of units for electromagnetism. The contributions of f_1^2 and f_2^2 to Δ have been investigated, in which Δ is defined as follows:

$$\Delta \equiv \mu_P + \mu_N - \mu_O$$

and μ_P, μ_N and μ_O are the proton magnetic moment, neutron magnetic moment, and the nuclear magneton, respectively. The contribution from f_1^2 is convergent and equal to

$$-\theta\,[f_1^2/(4\pi\hbar c)]\,(\mu_o/4\pi)$$

where θ is a number close to one, the exact value of which is partly dependent on the mass used for the meson. The contribution from f_2^2 is an expression of the form

$$f_2^2 \int_o^\infty g(x)dx$$

where $xg(x)$ tends toward a constant non-zero value when $x \to \infty$; in this case the previously obtained divergence remains. These results may be compared with the fact that the contribution from f_1^2 to the self-energy of a free nucleon diverges only in logarithmic fashion, while the contribution from f_2^2 results in a quadratic divergence. A necessary correction is made (in an appended note) which gives a semi-convergent expression for f_2^2.

2033 On the method of quantization of wave equations. R. Becker and G. Leibfried. *Z. Physik 125*, 347-58(1949)(in German).

The transition from the classical theory to the quantum mechanics requires that certain matrices or operators be attached to the classical wave functions. The authors conceive the magnitudes attached to the wave functions as operators, and show that a Hilbert space can be constructed, in which these operators are defined and the space elements are such as to lead, through quantization, to the Schrödinger equation. Although no new results are obtained, the method seems to describe the quantization theory in a simpler and shorter way than that currently used. Furthermore, operations on a Hilbert space with explicitly given elements are probably easier and clearer than the corresponding calculations with matrices.

2034 A quantum-mechanical treatment of multiple processes. N. Dallaporta. *Nuovo cimento 6*, 255-64(1949) July (in Italian).

By expanding in series the matrix element of the coulomb interaction of bremsstrahlung, it is possible to separate, in the total cross section of this process, parts corresponding to different values of the azimuthal quantum. In the quantum-mechanical treatment, these latter assume the physical meaning of parts corresponding to different values of the impact parameter in the semi-classical method of Weizsaecker and Williams. The results obtained with the two methods appear to be substantially similar.

2035 The theory of positrons. R. P. Feynman. *Phys. Rev. 76*, 749-59(1949) Sept. 15.

The problem of the behavior of positrons and electrons in given external potentials, neglecting their mutual interaction, is analyzed by replacing the theory of holes by a reinterpretation of the solutions of the Dirac equation. It is possible to write down a complete solution of the problem in terms of boundary conditions on the wave function, and this solution contains

PHYSICS (continued)

automatically all the possibilities of virtual (and real) pair formation and annihilation together with the ordinary scattering processes, including the correct relative signs of the various terms. In this solution, the "negative energy states" appear in a form which may be pictured (as by Stückelberg) in space-time as waves traveling away from the external potential backwards in time. Experimentally, such a wave corresponds to a positron approaching the potential and annihilating the electron. A particle moving forward in time (electron) in a potential may be scattered forward in time (ordinary scattering) or backward (pair annihilation). When moving backward (positron) it may be scattered backward in time (positron scattering) or forward (pair production). For such a particle the amplitude for transition from an initial to a final state is analyzed to any order in the potential by considering it to undergo a sequence of such scatterings. The amplitude for a process involving many such particles is the product of the transition amplitudes for each particle. The exclusion principle requires that antisymmetric combinations of amplitudes be chosen for those complete processes which differ only by exchange of particles. It seems that a consistent interpretation is only possible if the exclusion principle is adopted. The exclusion principle need not be taken into account in intermediate states. Vacuum problems do not arise for charges which do not interact with one another, but these are analyzed nevertheless in anticipation of application to quantum electrodynamics. The results are also expressed in momentum-energy variables. Equivalence to the second quantization theory of holes is proved in an appendix.

2036 The thermodynamics of the matter wave. Friedrich Kaempffer. *Z. Physik 125*, 487-96 (1949) (in German).

The behavior of an ideal gas at temperatures below the Einstein condensation point, (Einstein, *Zitzungsberichte Preussischen Akad. Wissenschaften 22*, 261(1924)) is described, in the light of the classical wave theory of matter. Laws are derived for the radiation in vacuum that correspond to those of Wien, Planck, and Stefan-Boltzmann.

2037 Thompson scattering and the hole theory. D. S. Kothari and F. C. Auluck. *Phys. Rev. 76*, 433(1949) Aug. 1. (Letter to the editor).

In the course of examining the problem of the effect of the radiation field on the electromagnetic shift of the s-level of the H-atom, the modification of the scattering cross section of the free electron when it belongs to an assembly of a degenerate Fermi-Dirac gas was also considered. It was noted that the cross section for this case is affected differently according to whether the original theory or the hole theory is used. As Halpern and Hall (*Phys. Rev. 75*, 910(1949)) have concluded, the results obtained indicate that not only the proof concerning the equivalence of the two versions of the theory is erroneous, but also the two theories lead to different predictions concerning experimental results. Even for Thompson scattering the results are identical only when an isolated electron is considered and are different if the electron is the constituent of a degenerate gas.